THE IMPACT OF EXCHANGE RATE ADJUSTMENTS ON THE UNITED STATES FRESH TOMATO INDUSTRY: POLICY IMPLICATIONS FOR THE UNITED STATES AND MEXICO

By

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THE IMPACT OF EXCHANGE RATE ADJUSTMENTS ON THE UNITED STATES MARKET FOR FRESH TOMATOES: POLICY IMPLICATIONS FOR THE UNITED STATES AND MEXICO

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This study investigated pass-through of changes in exchange rates, substitute prices, production costs, tariff rates and income to import prices of Mexican fresh tomatoes in the United States market from January, 1978 to June, 1996. The role of these variables plus seasonally related factors in explaining Mexico's share of the United States fresh tomato market was concurrently investigated.

A Bertrand price setting conceptual framework was adopted from which an empirical import price specification was derived. The simultaneous study of dynamics of short run adjustments and long run equilibrium was facilitated by cointegration and error correction. Dynamics were incorporated through an autoregressive distributed lag representation in

which lag structure and dynamic effects of explanatory variables on import prices were determined by the data.

Conceptually, changes in market shares instead of quantities should be invariant to most demand side factors. The logistic function proves ideal for modeling shares because it transformed the bounded dependent share variable to one which is unbounded.

Data properties were investigated using stationarity and cointegration tests. The error correction import price and market share equations were estimated using OLS. A general to specific modeling strategy was applied to obtain the final estimated import price equation. The share equation was corrected for autocorrelation using the Hildreth-Lu procedure.

The empirical results confirmed that pass-through to tomato import prices of changes in (a) exchange rate was incomplete for short run and complete for long run; (b) tariff rate was complete for short run and incomplete for long run; (c) domestic shipping point prices and wages were incomplete for short run and long run; and (d) domestic income was more than complete in the short run and long run. Parameter nonconstancy was confirmed by a break in the import price pass-through relationship, implying that Mexican fresh tomato exporters altered pricing strategies in response to exchange rate changes.

For the share equation, technology, freezes in December and February and the winter season dummy were important determinants of Mexican market share. Other determinants and their pass-through status were (a) real exchange rate, Mexican wage and domestic income were complete; and (b) real tariff rates and Mexican import prices were incomplete.

CHAPTER 1

INTRODUCTION

Florida and Mexico are the dominant suppliers of fresh tomatoes to the United States consumer. Over the past 19 years (1978-96) their combined share of apparent United States (domestic) consumption averaged 95, 70, 14, and 59 percent for the marketing windows January to March (Winter), April to June (Spring), July to September (Summer), and October to December (Fall), respectively. Historically, the Florida-Mexico market share rivalry has been most intense in the January to April market period because these producing areas lie on the same latitude and share similar agro-climatic conditions.

Excluding disruptions caused by weather, fresh tomato shipments from Mexico supply most west coast markets, those from Florida supply most of the east coast. Both suppliers compete in the center of the country on the basis of delivered costs (Angirasa and Davis, 1996). Despite this established marketing pattern, Florida and Mexico compete in each other's primary market during some months of the crop year. Analysis of 1994 data from 22 major United States cities showed that 15 percent of Mexico's volume went to 9 eastern cities and Florida shipped 13 percent of its volume to four western cities (Love and Lucier, 1996).

Over the years, the Florida-Mexico rivalry survived many regulatory and economic adjustments. The 1962 United States embargo on Cuban imports and termination of the Mexican guest-worker program in 1964 are examples of early regulatory actions which helped

establish Mexico as a serious competitor in the United States fresh vegetable market (VanSickle et al., 1994). Economic forces influencing the competition include significant flows of United States investments into Mexico's vegetable sector, improved communication between Mexican producers and their United States based distributors, large public sector investments in roads and irrigation facilities in Mexico (Firch and Young, 1968) and relatively cheaper Mexican labor (VanSickle et al., 1994).

Mexico's share of the United States fresh tomato market grew consistently in the 1960s and early 1970s, despite tariff (Zepp, 1982) and higher transportation costs (Thompson and Hillman, 1989). Florida producers attempted relentlessly to reverse their declining market share using discriminatory regulations to restrict Mexican competition (Schmitz et al., 1981; Bredahl et al., 1983, 1987; Thompson and Hillman, 1989; USITC, 1996).

The United States winter fresh tomato (WFT) trade is regulated by the Federal Marketing Order (FMO) which was established under the Agricultural Marketing Agreement Act of 1937. In Florida, the FMO for tomatoes has been administered by the Florida Tomato Committee (FTC). Amendments to the 1937 law imposed similar minimum standards on domestic and imported fresh tomatoes. During the 1968/69 season, the USDA implemented "dual size" restrictions. This allowed mature-greens (dominated by Florida) to be marketed in smaller size compared to vine-ripes (dominated by Mexico). Approximately 40 percent of the fresh tomatoes imported from Mexico during the 1967/68 season would not have satisfied these restrictions (Bredahl et al., 1983). The dual size restriction was revoked in 1973 following legal challenges by consumers and importers of Mexican fresh tomatoes.

The battle for the United States WFT market intensified in October, 1978, when Florida growers filed dumping charges alleging that Mexican tomatoes were being sold in the United States at "less than fair value" (Schmitz et al., 1981; Bredahl et al., 1987). The United States Department of Commerce ruled in favor of Mexico, based on the "third-market test" which demonstrated that Mexican tomatoes were sold in the United States and Canada at equal FOB values (Schmitz et al., 1981; Bredahl et al., 1987; Thompson and Hillman, 1989).

Commencing in the 1970s, Mexico circumvented potentially more restrictive import controls by the United States and implemented planted area quotas (PAQs) and voluntary export restraints (VERs). Mexican growers expected to benefit from this supply management strategy through higher prices in the short run and increased market share in the long run. Their long term expectations did not materialize because the Florida industry did not diminish, as Mexican producers anticipated. Instead, Florida gained market share in the 1980s because of three principal factors. First, a market structure which was favorable to Florida emerged, facilitated in part, by Mexican supply controls. This led to a decline in the intensity of the competition and more than a decade of calm between the rivals (VanSicke, 1996). Second, rapid adoption of improved technology by Florida producers enhanced productivity and lowered per unit production costs (Kalaitzandonakes and Taylor, 1990; VanSickle et al., 1994; Tefertiller and Ward, 1995). Consequently, Florida growers de-emphasized regulatory measures and expanded their market share based on efficiency. Third, macroeconomic changes over time altered relative profitability and market shares in both industries.

Three macroeconomic events with important ramifications for the supply of fresh tomatoes in the United States market deserve mention. First, Mexico embarked on major

economic reforms in the period 1982 through 1986. These reforms were reinforced in 1987 through 1996 by the Economic Solidarity Pact. This agreement among government, labor unions and entrepreneurial groups consisted of (i) exchange rate adjustments to close the gap between official and market rates; (ii) wages were indexed to inflation; (iii) Mexican prices were exposed to foreign competition to counter inflation; and (iv) greater fiscal responsibility was exercised. In addition, to emphasize its commitment to an open market paradigm, the Mexican government signed the General Agreement on Tariffs and Trade (GATT) in 1986.

The North American Free Trade Agreement (NAFTA) symbolizes the second major macroeconomic development. This trilateral accord between the United States, Canada and Mexico became operative January 1, 1994. NAFTA's explicit objectives were to eliminate tariff and nontariff barriers and liberalize the investment and transportation sectors of participating countries. Its implicit objective was to make credible Mexico's reforms and commit that country to a specific schedule for removing remaining interventionist policies.

Third and possibly the most substantive macroeconomic development has been the dynamic nature of Mexio's exchange rate policy. Since 1954, Mexico has implemented four different exchange rate policies. These are the anchor or fixed exchange rate, crawling-peg, moving band and the free float. Differentials in the rate of inflation in Mexico relative to the United States have resulted in episodes of over- and undervaluation. Overvaluation penalized exports and subsidized imports; undervaluation achieved opposite effects. Most analysts concur that periodic over- and undervaluations of the peso-dollar exchange rate have always been a major determinant of the share of the United States fresh tomato market held by Florida and Mexico (Zepp and Simmons, 1979; Bredahl et al., 1983, 1987; VanSickle, et al.,

1994; Love and Lucier, 1996; USITC, 1996). Bredahl et al. (1983) demonstrated that during the 1970s Florida expanded its market share because of peso overvaluation. In contrast, the peso was undervalued in the 1976/77 season and Mexico gained additional market share. Undervaluation coincided with antidumping claims by Florida growers in 1978. Similarly, the antidumping claims of 1995 and 1996 were associated with episodes of peso undervaluation.

Continuous fluctuation in the peso-dollar exchange rate since 1976 and the highly publicized devaluations from December, 1994, to March, 1995, have forced Florida growers to revert to a regulatory mode reminiscent of the late 1970s. First, in March, 1995, the Florida Tomato Exchange (FTE) filed a Section 201 petition with the United States International Trade Commission (USITC), seeking protection from growing imports of Mexican WFT. The petitioners requested the USITC to take the following actions:

(i) define the domestic WFT industry exclusively as those entities producing and shipping fresh tomatoes during the January to April market period. The request for this definition was justified because the United States WFT market is effectively supplied by Florida and Mexico, and the competition is most intense during this period;

(ii) recommend provisional relief by increasing the tariff on WFT imports by 50 percent;

(iii) grant permanent relief in the form of an import quota for the maximum period allowed by law; and

(iv) recommend market-sharing negotiations between Florida and Mexican growers.

The USITC ruled against the Florida petitioners, contending that Florida's winter crop could not be afforded special considerations based on seasonality. The USITC investigation defined a full-year industry, found no significant increase in imports from Mexico (expressed

annually or on a January to April basis) and no substantial injury to the domestic industry resulting from increased imports. Finally, given the timing of the request, the USITC did not believe it could provide effective provisional relief (USITC, 1995).

Second, in 1996, a group of Florida growers, the Florida Department of Agriculture, and growers from several other states filed a section 201 petition for import relief with the USITC. This was followed by an antidumping petition charging that Mexican tomatoes have been dumped on the United States market (Love and Lucier, 1996) at less than fair value. Preliminary investigations by the USITC found reasonable evidence that a domestic industry was injured or threatened with injury because of dumping. In October, 1996, a compromise was reached, Mexico agreed not to sell WFT in the domestic market below a reference price of $0.46 per kg (Florida Department of Agriculture and Consumer Services, 1996).

Specific Statement of Problem

Producers, distributors, input suppliers, transportation firms, consumers and policy makers share a veritable concern pertaining to the potential economic impact of frequent and significant adjustments to the peso-dollar exchange rate on the domestic fresh tomato market. However, adequate and timely economic assessment of these concerns is hampered by the absence of an appropriate theoretical and empirical framework. Such a framework is basic for understanding and explaining how fluctuations in the peso-dollar exchange rate coupled with changes in trade policy affect import prices and trade volumes in the domestic market for fresh tomatoes. It is significant also in formulating policies for future sustainability and profitability of the respective industries.

Adjustments in the peso-dollar exchange rate have renewed the debate concerning the relationship between exchange rates and agricultural trade policy. This is evident from recent filings of complaints with the USITC and the Department of Commerce and speculations in the popular press and farming circles regarding the negative impacts of peso devaluation and NAFTA on Mexico-United States agricultural trade in general, and tomato trade in particular. Concerns are high among Florida tomato growers for two main reasons. First, most studies conclude that the domestic winter fresh vegetable industry will be among the main losers under NAFTA trade provisions (Congress of the United States, 1993a; 1993b; 1993c). Further, the distribution of losses is expected to be higher in major producing areas of Florida. Second, this prediction was strengthened by the recent weakening of the peso against the dollar and the simultaneous surge in Mexican imports. Peso devaluation is alleged to

(a) lower fresh tomato prices in the domestic market;

(b) increase the volume of fresh tomatoes imported from Mexico; and

(c) reduce the market share, profitability and employment in the domestic industry.

In addition, it has been suggested that lower tariffs and the increased confidence generated by NAFTA have enhanced the supply response of Mexican tomato export producers.

The partial equilibrium trade model depicted in Figure 1, illustrates that devaluation of the peso is consistent with these alleged impacts. The supply of Mexican tomatoes (S_m) is depicted in Panel A. Initially, 1 peso is assumed to be exchanged for 1 dollar, this is represented by the 45 degree line (OA_0) in Panel B. The United States excess demand for tomatoes (ED_T) is depicted in Panel C of the trade sector diagram. The United States supply (S_{US}) and demand (D_{US}) are shown in Panel D. The vertical axes in panels A and B depict

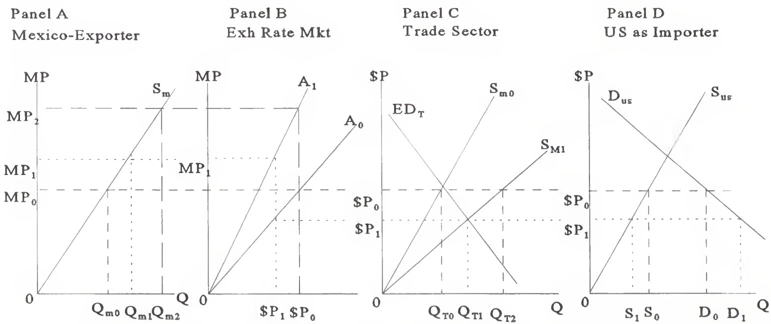

Figure 1. Partial Equilibrium Model of Exchange Rate Pass-Through

Mexican peso price (MP), and those in panels C and D show prices in dollars ($P). In panel (B) the horizontal axis depicts prices in dollar ($P). The remaining horizontal axes represent quantities. At the initial equilibrium, prices are ($$P_0$) and ($MP_0$), quantities supplied by Mexico are (Q_{m0}), the trade sector receives (Q_{t0}), the quantities supplied and demanded in the United States are (OS_0) and (OD_0), respectively, and quantities imported from Mexico are (OD_0-OS_0).

The counter-clockwise rotation of line OA_0 to OA_1 in panel B reflects a 50 percent devaluation of the peso against the dollar. At the new exchange rate Mexican export producers receive (MP_2), which is twice the pre-devaluation price. Since price in pesos has increased, Mexican export producers are motivated to supply a larger quantity (Q_{m2}). The new supply quantity, labeled (S_{m1}) in the trade sector diagram, indicates that at the initial dollar price for tomatoes, Mexican export producers are willing to supply a larger quantity. When supply and demand in the trade sector ultimately achieve a new equilibrium, the quantity exported will be somewhat less than (Q_{T2}) and the dollar price less than ($$P_0$). Thus, devaluation of the peso reduces (increases) the equilibrium dollar (peso) price and increases the quantity imported from Mexico. At the new equilibrium import price ($$P_1$) where the excess demand and excess supply curves intersect, the quantity ($0Q_{T1}$) is imported. The quantity supplied by domestic producers falls to ($0S_1$) and that demanded increases to ($0D_1$).

Several problems are inherent with the conclusions of this conventional trade model. First, it presumes that exchange rate changes are fully transmitted or passed-through to import prices. Accordingly, the impression is conveyed that a given percentage peso depreciation immediately translates into a proportional reduction in the import price of

Mexican tomatoes. Second, complete exchange rate pass-through presumes instantaneous price adjustment, perfectly competitive market structure, perfect substitutability, perfect information, and perfect goods arbitrage. These assumptions are the core of the law of one price (LOP) model of international trade.

Third, violation of one or more of these assumptions implies failure of LOP. If LOP does not hold, it means tomato exporters or importers can cut the link between prices and exchange rates. In this regard, some economists have argued that for certain products, exporters and importers might not pass-through the effects of a depreciation or appreciation but, instead, might absorb the changes in their profit margins (Feldman, 1982; Dunn, 1970). If this were to occur, the supply and demand changes depicted in Figure 1, in response to an exchange rate change, might not occur and trade volumes would be unaffected.

Fourth, the existence of transport costs and trade barriers (which LOP assumes away) may result in incomplete or zero pass-through of exchange rates to import prices (Moreno, 1989; Feldman, 1982; Dunn, 1970). Equally important, the conventional wisdom has not explicitly emphasized the importance of factors other than the exchange rate in determining the changing nature of market shares. These other factors include changes in production techniques and the associated costs of production, changes in trade policy (e.g., tariff), grower prices, weather, market structure, product characteristics, degree of foreign competition, exchange rate expectations and time lags.

Since empirical evidence identify these factors as important in exchange rate impact evaluation (Dixit, 1989; Dornbusch, 1987; Venables, 1990), a synopsis of their impacts in the context of the fresh tomato industry is in order.

Changes in Technology and Cost of Production

Technology and changes in the cost of production are integrally related. Adoption, in recent years, of extended shelf life (ESL) varieties and drip irrigation technology by Mexican tomato producers have been described as two long-run factors that resulted in higher yields and lower costs per unit and facilitated Mexico's increased supply response (Love and Lucier, 1996). On the other hand, Florida's yield trend is flat and input costs are rising; therefore, costs per unit have been rising (Love and Lucier, 1996).

Grower prices and weather affect the ability of United States and Mexican growers to compete in the domestic market. Weather has been a prime factor in determining price outcomes in many seasons. Freezes destroyed much of Florida's tomato crop in 1977, 1981, 1982, 1984, 1985, 1989, and 1990, as did tropical storm Gordon in 1994. These tended to boost prices when Mexican producers had their largest volume of shipments. In some years this has been a factor helping Mexico to maintain a large share of the United States market.

Changes in trade policy and the confidence they generate for Mexican shippers are frequently ignored. Duties on fresh vegetable imports were established to protect domestic producers (Firch and Young, 1968). Average prices of tomatoes and other vegetables have increased over time and relative tariff rates on these vegetables have declined from a high of roughly 17 percent in 1974 (Zepp, 1982) to about 5 percent currently. This decline has diminished the importance of tariff in protecting the domestic industry (VanSickle, 1996).

Timing and duration of exchange rate impact are rarely emphasized in the debates. The advantage a devaluation provides to Mexican growers is a short-run phenomenon. It depends, in part, on the extent to which inputs used in production are produced in Mexico

and are paid for in pesos. For example, wages of Mexican tomato workers do not necessarily change at the time of devaluation. Hence, immediately after devaluation a dollar earned from export sales will purchase more hours of labor than it did before. Thus, peso devaluation, ceteris paribus, tends to give Mexican growers an advantage over their Florida counterparts, at least for the short run. On the other hand, those production inputs which Mexican growers purchase from the United States must be paid for in dollars and are not cheaper relative to receipts from export sales. Accordingly, in the medium term, export gains from devaluation are expected to be offset by higher rates of inflation.

In summary, peso devaluation provides above normal profits to Mexican tomato growers for a short time period. But eventually, higher costs of imported inputs (seeds, transportation services, cartons, machines, chemicals, and irrigation equipment) are paid for in dollars. Therefore, prices paid by Mexican growers rise when the peso is devalued.

There have been no comprehensive examinations of the economic impact of exchange rate and cost changes on the domestic market for fresh tomatoes. What have been presented are intuitive indicators of factors which may contribute to explaining economic impacts.

The alleged impacts of devaluation must be evaluated in the context that it can result in different consequences, depending on the extent of exchange rate pass-through (i.e., the responsiveness of import prices to changes in exchange rates). Specifically, peso devaluation can result in one of several possibilities:

(a) improve Mexican market share in proportion to the depreciation with no change in profit margins (complete pass-through);

(b) improve Mexican market share and profit margins, the exact proportions depend on

the pass-through coefficient (incomplete pass-through); and

(c) increase profit margins of Mexican exporters and domestic importers in proportion to the depreciation with no change in market share (the zero pass-through scenario).

Objectives

The broad objective of this study is to provide an appropriate theoretical and analytical model for evaluating the impact of exchange rate adjustments on the United States market for fresh tomatoes. The specific objectives are to test hypotheses regarding

(i) short and long run impacts of exchange rate changes on tomato import prices;

(ii) stability of exchange rate pass-through across episodes of exchange rate adjustments;

(iii) pass-through of tariff changes to import prices; and

(iv) impact of exchange rate changes on market share.

Hypothesis 1. The first hypothesis asserts that the pass-through of exchange rate changes is incomplete in the short run but complete in the long run. Incomplete exchange rate pass-through in the long run may indicate, among other things, that

(a) Mexican exporters employ noncompetitive strategies to maintain or increase market share (Pompelli and Pick, 1990; Baharumshah and Habibullah, 1993); and

(b) peso devaluation or appreciation has limited impact on tomato export volumes.

Hypothesis 2. The second hypothesis states that the transmission of changes in exchange rates and Mexican wage rates to United States import prices is strongest during episodes of peso devaluation, and weakest during episodes of peso appreciation. This is the familiar "ratchet hypothesis" tested by Goldstein (1977) and Jabara and Schwartz (1987).

Pass-through of exchange rate changes to domestic import prices may have differed over the various exchange rate regimes (fixed, crawling peg, and flexible rates).

Stable patterns of pass-through indicate symmetry in the response of import prices to exchange rate movements. That is, the extent to which domestic import prices fall when the peso depreciates equals the extent to which they rise when the peso appreciates. A finding of stable pass-through means that Mexican tomato exporters have not altered their pricing strategies as a result of large adjustments in exchange rates.

Hypothesis 3. Two hypotheses regarding tariff rates will be evaluated, these are

(a) pass-through of tariff rates to import prices are the same for the full sample period and the Mexican open market reform sub-period; and

(b) changes in exchange rates and tariffs have identical effects on import prices. This symmetry hypothesis was tested by Feenstra (1989) and Pompelli and Pick (1990).

Hypothesis 4. The last hypothesis contends that Mexico has not increased its market share because of real exchange rate devaluations. This proposition is reasonable, since many countries with depreciating exchange rates experience no gain in market share due to high inflation rates (Moreno, 1989).

Justification

Despite the importance of the pass-through relationship in explaining Mexican tomato export performance, no empirical studies have addressed this issue. The concept of exchange rate pass-through is important in formulating exchange rate and trade policy for at least three reasons. First, if exchange rate changes are not fully or substantially reflected in tomato

import prices, then peso devaluations are unlikely to exert strong influences on the volume of tomato imports. Second, investigating the pass-through phenomenon provides important information regarding the structure of the import market. For example, if the United States tomato market is perfectly competitive, and elasticity of supply is infinite, changes in peso exchange rate should pass-through completely to domestic import prices (Kreinin, 1977). If the market is noncompetitive pass-through will be incomplete. Third, low pass-through may be ascribed to tariff and non-tariff barriers (Bhagwati, 1988). Finally, organizational forces may enhance market power thereby adversely affecting pass-through.

Methodology, Scope and Organization of the Study

A Bertrand imperfect competition model is employed in this study to evaluate the pass-through of exchange rate changes to import prices for fresh tomatoes in the United States market. A partial equilibrium empirical model which incorporates dynamics in a theoretically consistent way is formulated. Time series properties of the data are investigated and selected hypotheses tested based on the empirical estimates.

Considering the stated objectives of the study, the literature includes both theoretical and empirical studies of exchange rate pass-through and the strategic pricing behavior of exporting and importing firms. The market under consideration is the United States market for fresh tomatoes. A homogeneous commodity is assumed, since there are no fundamental intrinsic differences between tomatoes supplied by the United States and Mexican growers. For this study the market for fresh tomatoes is defined on a 12 month (full-year) basis and covers the years 1978 to 1996.

The remainder of the study is organized as follows. In chapter 2, an overview of the industry is provided with emphasis on structure, conduct and performance. Chapter 3 contains a review of the literature on exchange rate pass-through studies. The conceptual and empirical framework is developed in chapter 4. Chapter 5 covers empirical implementation, presentation of the results and hypotheses testing. Chapter 6, summarizes the study, including the substantive policy implications, conclusions and suggestions for future research.

CHAPTER 2

OVERVIEW OF THE MACROECONOMY AND FRESH TOMATO INDUSTRY

The first part of this chapter explores the macroeconomic environment in which the United States and Mexico compete for market shares. The second portion highlights some important economic and institutional characteristics of the tomato industries of Mexico and the United States. The third section explains potential impacts of selected macroeconomic changes on fresh tomato production and marketing. Although the impact of exchange rate adjustments is emphasized, other aspects such as changes in trade policies are considered. This background analysis is essential for understanding how the industries function and respond to external shocks. More importantly, it provides insights in formulating a suitable analytical model and interpreting the empirical results.

The Macroeconomic Environment

Over the past 25 years, the macroeconomic environment has changed key economic, structural and institutional variables which influenced agricultural trade between Mexico and the United States. The fundamental macroeconomic shifts which occurred in Mexico are summarized in terms of four major periods. Namely, the stabilizing development, shared development, oil boom and debt crisis, and the open market period. Discussion of these periods draws heavily on the data presented in Tables 1 and 2.

Table 1. Macroeconomic indicators: Mexican and United States economies (1970-1996)

Years	Exchange rates			Inflation[d]		COC[e]	CNWGE[f]
	Nominal[a]	PPP[b]	OUV[c]	Mexico	USA	.....Percent.....	
1970	12.50	13.21	1.06	5.21	4.4		
1975	12.50	13.18	1.05	15.15	9.1	11.9	18.9
1976	19.95	14.58	0.73	15.79	5.7	11.8	25.4
1977	22.74	17.72	0.78	29.00	6.9	12.9	30.9
1978	22.72	19.31	0.85	17.46	7.7	15.1	15.2
1979	22.80	20.28	0.89	18.17	11.3	16.4	16.5
1980	23.26	22.45	0.97	26.36	13.5	20.7	22.7
1981	26.23	26.32	1.00	27.93	10.3	28.6	32.5
1982	96.48	41.01	0.43	58.92	6.1	40.4	60.2
1983	143.93	81.71	0.57	101.76	3.2	56.6	56.1
1984	192.56	132.11	0.69	65.54	4.3	51.1	54.9
1985	371.70	209.40	0.56	57.75	3.6	56.1	59.6
1986	923.50	401.59	0.43	86.23	1.6	80.9	75.7
1987	2209.70	907.07	0.41	131.83	3.7	94.6	134.2
1988	2281.00	1867.52	0.82	114.16	4.0	67.6	112.2
1989	2641.60	2135.34	0.81	20.01	4.8	44.6	33.7
1990	2945.40	2611.41	0.89	26.65	5.4	37.1	30.5
1991	3071.00	3196.09	1.04	22.66	4.2	22.6	29.1
1992	3115.40	3671.01	1.18	15.51	3.0	18.8	17.5
1993	3105.90	3969.69	1.28	9.75	3.0	18.6	8.6
1994	3325.00	4193.03	0.79	6.97	2.6	15.5	6.0
1995	7642.50	5463.56	0.71	35.00	2.8	45.1	10.1

[a] Nominal exchange rate in pesos per dollar; [b] Purchasing power parity exchange rate;
[c] Measure of over- or undervaluation; [d] Percentage annual inflation rate;
[e] Average cost of capital; [f] Change in nominal Mexican wage rate.

Table 2. Fundamental changes in Mexico's exchange rate policy (1954-1996)

Time periods	Changes in exchange rate policy
1954 to 1975	Nominal exchange rate fixed at 12.5 pesos/dollar
1976 to 1982	Nominal exchange rate fixed, but adjusted to reduce differentials between domestic and foreign inflation.
1982 to 1985	Nominal exchange rate fixed, but adjusted to reduce differentials between domestic and foreign inflation.
1985 to January, 1988	Nominal exchange rate fixed
February, 1988, to December, 1988	Nominal exchange rate fixed at 2281 pesos per dollar
January, 1989, to December,1989	Preannounced rate of devaluation set at one peso per day.
January, 1990, to December, 1990	Preannounced rate of crawl set at 80 centavos per day.
December,1990, to November,1991	Preannounced rate of crawl set at 40 centavos per day.
November, 1991, to October, 1992	Exchange rate band adopted, floor is fixed at 3050 pesos per dollar, while ceiling slides at 20 centavos per day.
November, 1992, to December, 1994	Rate of devaluation of band's ceiling is accelerated to 40 centavos per day, Bank of Mexico intervened through March, 1994 to maintain the rate within narrower band.
December 22nd to December 23rd, 1994	Ceiling of band increased 15 percent
December 22nd, 1994 to present.	Exchange rate floated freely against the dollar.

Source: Compiled using selected benchmark data from Dornbusch and Werner (1994) and Gould (1995).

The stabilizing development period, 1954-1970, epitomizes an era of financial stability in Mexico. The exchange rate was anchored at 12.5 pesos per dollar throughout the period. Convertibility of the peso was unrestricted, inflation rates were modest (averaging about 3.9 percent per annum) and real per capita income grew at annual rates of 3.1 percent (Gould, 1995; Dornbusch and Werner, 1994; Villa-Issa, 1990). Villa-Issa (1990) estimates that during this period the peso was overvalued by approximately 22 percent.

The shared development period, 1971-77, was an era of expanded import substitution or an inward looking paradigm. This was facilitated by anchoring the nominal exchange rate to the United States dollar. Tariffs and quotas were high, import licensing, price controls and subsidies were prevalent. The public sector was growing and fiscal and monetary policies were expansionary. In addition, external borrowing was used to support the fixed exchange rate (Dornbusch and Werner, 1994). These policies jeopardized Mexico's ability to compete internationally, promoted rent seeking and capital flight (Dornbusch and Werner, 1994).

Table 1 shows that from 1970 to 1975 peso overvaluation ranged from 3 to 6 percent. In September, 1976, a balance of payment crisis caused a 60 percent devaluation of the peso (Gould, 1995). Between 1976 and 1977 the peso was devalued further by another 14 percent; however, it was undervalued by 27 and 22 percent, respectively, each year. For the entire period, the peso lost 82 percent of its value.

The oil boom and debt crisis period, 1978-86, commenced with oil discoveries which brought dramatic changes in the balance of payments and expectations concerning future growth. The fall of oil prices in 1982 and the rise in United States interest rates were important factors in Mexico's announcement that it could not meet scheduled debt payments

(Espana, 1995; Gould, 1995). This disclosure marked the beginning of the debt crisis. Over this 9-year period the peso-dollar exchange rate increased from 22.72 to 923.3 (Table 1). Annual rates of inflation accelerated from 17 percent in 1978 and reached 102 percent in 1983 but declined to 86 percent at the end of the period. The average cost of capital increased dramatically from 15 percent to 81 percent. Inflation in nominal wage rates followed a similar pattern, going from 15 percent in 1978 to 75 percent in 1986. Deficit reduction targets during the early reform years (1982-1986) led to lower subsidies for agriculture, while peso undervaluation increased production costs (Villa-Issa, 1990).

The agricultural sector, however, benefited from price controls on inputs produced by the public sector. For example, the implicit price index rose by 478.6 percent; however, prices of gasoline, farm tractors and fertilizers grew by only 148.6, 185.7 and 171.5 percent, respectively (Villa-Issa, 1990).

The open market reform period, 1987-1996, began with the pact for economic solidarity, signed in 1987 by government and representatives of labor, farming, and business. This was subsequently complemented by the Pact for Stability and Economic Growth. These two measures, referred to as the PACTO, combined fiscal and monetary restraint with structural reforms and price and wage controls (Gould, 1995). Early stages of the PACTO emphasized fiscal and macroeconomic adjustments, price and wage controls, and debt renegotiation. Later stages focused on deregulation and privatization.

Table 2 shows the different exchange rate policies adopted during this period. First, anchoring the peso to the dollar remained in force between January, 1987, to December, 1988. This resulted in devaluation (131 percent) of the peso-dollar exchange rate from 988

to 2281. For this brief period the annual rate of growth in inflation, average cost of capital and nominal wages declined 14, 28, and 16 percent, respectively.

Second, the exchange rate crawl option was introduced in January, 1989 (Table 2). Initially, the crawl was set at 1 peso per day (January to December, 1989) and the peso lost 14 percent of its value. Subsequently, the rate of crawl was reduced to 80 centavos per day (January to December, 1990) and the peso lost 10 percent of its value. The rate of crawl was further lowered to 40 centavos per day (December, 1990, to November, 1991) and the peso depreciated from 2,945 to 3,073. Overall, the exchange rate crawl depreciated the peso by 36 percent (2310 to 3132). Annual inflation increased from 20 percent in 1989 to 26 percent in 1990, then fell to 23 percent in 1991. For the corresponding period annual inflation rates in the United States fell from 5.4 to 4.23 percent.

Third, an exchange rate band was adopted between November, 1991, to December, 1994. Initially, the floor of the band was 3050 pesos per dollar, with a sliding ceiling of 20 centavos per day. Later, the rate of devaluation was accelerated by increasing the ceiling to 40 centavos per day. During these periods the Bank of Mexico intervened to maintain the narrower band. Under this regime, the peso-dollar rate depreciated (73 percent) from 3,073 to 5,325. Annual inflation fell to 23, 16, 10 and 7 percent in 1991, 1992, 1993 and 1994, respectively. Inflation in average cost of capital and wages followed a similar trend.

Under the open market reform, government spending as a percent of GDP fell from 44 to 26 percent, and overall fiscal deficits as a percent of GDP fell from 16 to 0.3 percent. Many observers interpreted these indicators as signals of sound economic fundamentals which would ensure sustained growth and stability in Mexico.

A freely floating exchange rate policy was adopted on December 23, 1994. By March, 1995, the peso had fallen more than 50 percent against the dollar (Espana, 1995), inflation, average cost of capital and nominal wages were growing at annual rates exceeding 35, 45, and 10 percent, respectively.

The NAFTA was the other important macroeconomic development occurring in this period. This agreement among the United States, Canada and Mexico came into effect January 1, 1994. It created the largest free trade area within the hemisphere with a population of over 360 million people, producing over \$6.2 trillion worth of goods and services, and trade in excess of \$1.0 trillion worth of goods (Williams and Rosson, 1992).

The most important agricultural provisions of NAFTA are those addressing (a) market access, namely, removal of trade barriers, special safeguards for sensitive products and sanitary and phytosanitary requirements; (b) liberalizing the investments and transportation sectors of participating countries; and (c) protection of property rights.

The above synopsis illustrates salient features of the macroeconomic environment of the Mexican fresh tomato industry over the past 25 years. Subsequent discussion will highlight how these factors impacted the Mexican and United States industries.

The United States Market for Fresh Tomatoes

United States agricultural exports to Mexico during the first year of NAFTA (1994) exceeded imports by roughly \$1.6 billion (Table 3). This is the largest agricultural trade surplus the United States has ever achieved with Mexico. Fresh vegetables were responsible for \$47 million (1%) and fresh tomatoes accounted for \$14 million (0.3%).

Table 3. Selected indicators of United States-Mexico agricultural trade

Indicators	1990	1991	1992	1993	1994	1995
US exports to Mexico						
Total Agriculture[a]	2553	2999	3791	3603	4513	3519
Fresh vegetables[a]	18	23	37	35	47	17
Fresh tomatoes[a]	2	4	10	10	14	1
Fresh tomatoes[b]	0.1	0.1	0.3	0.3	0.3	0.4
Mexican exports to US						
Total Agriculture[a]	2611	2527	2372	2709	2855	3780
Fresh/frzn vegetables[a]	899	790	699	931	992	1186
Fresh tomatoes[a]	371	250	133	304	316	406
Coffee[a]	338	333	252	251	333	592
Fresh tomatoes[b]	14.2	9.9	5.6	11.2	11.1	10.7
Coffee[b]	12.9	13.2	10.6	9.3	11.7	15.7
Competitive vegetable trade						
US exports to Mexico						
Fresh tomatoes[a]	0.8	1.3	9.6	2.1	3.1	0.4
Fresh tomatoes[c]	1340	2430	1432	3458	4467	730
Mexican exports toUS						
Fresh tomatoes[a]	231	110	263	260	313	531
Fresh tomatoes[d]	310	155	316	323	439	552
Fresh/frzn vegetables[a]	694	575	825	825	1015	1159
Fresh/frzn vegetables[d]	1056	888	1210	1206	1417	1732
Florida shipments to US						
Fresh tomatoes[a]	492	616	528	410	363	388

[a] implies million US$; [b] implies (%); [c] implies metric tons; [d] implies (000) metric tons
Source: Ramos, T. (1996). NAFTA Trade and Economic Development Database (Computer File), Washington D.C., Economic Research Service, USDA.

Mexican agricultural exports to the United States for the corresponding period were $2.9 billion. Fresh tomatoes accounted for $316 million (11%) and coffee accounted for $333 million (12%). United States agricultural exports to Mexico fell to $3.5 billion in 1995 and the contribution of fresh tomatoes ($1.3 million) was the lowest for the years considered in Table 3. In contrast, Mexico's agricultural exports to the United States reached a record $3.8 billion. Fresh tomatoes accounted for 11 percent or $406 million. The agricultural trade surplus which Mexico earned with the United States in 1995 may be attributed to the peso devaluation which made Mexican exports cheaper to domestic consumers and United States goods more expensive for Mexican consumers.

Traditionally, the most valuable agricultural export from Mexico to the United States is coffee, while tomatoes is the most valuable horticultural export. However, Mexican fresh tomato exports to the United States in 1990 and 1993 ($371 and $304 million) exceeded that for coffee ($338 and $251 million). Table 3 also shows that in 1991/92 Mexican fresh tomato exports which competed with Florida's production (November to June) were valued at $110 million (154,850 mt). This increased to $531 million (551,620 mt) in 1995/96. For the corresponding period Florida's shipments declined from $616 million to $363.2 million. The volume of Mexican fresh tomato exports to the United States in 1994/95 was 20 percent above 1993/94 but the value was 36 percent higher. In contrast, the 1995/96 volume was 70 percent higher than that of 1994/95, but the value was only 26 percent higher, indicating that devaluation of the peso may have substantially reduced tomato import prices.

Long Term Fresh Tomato Market Share Trends

Long term average monthly shares of the United States fresh tomato market held by Florida (FLSH), Mexico (MXSH), other domestic suppliers (ODSH) and other foreign suppliers (OISH) for winter, spring, summer and fall market windows are shown in Table 4.

The United States winter market window was supplied primarily by Florida (50%) and Mexico (45%), with a combined share of 95 percent of the market. Figure 2 shows that in February and March Mexico dominates the market with shares of 52 and 50 percent, respectively, compared to Florida's share of 44 and 43 percent, respectively.

Market shares in the spring market window were also dominated by Florida (48%) and Mexico (22%). In June other domestic suppliers (mainly California) controlled the market with 48 percent, relative to 25 percent for Florida and 15 percent for Mexico. Other domestic suppliers were dominant in the summer market window with 75 percent of the share. The fall market window represents a transition period when the share of other domestic suppliers falls to approximately 36 percent, while that of Florida rises to around 48 percent. Mexican share remained relatively steady (12%) during this market window.

The data reveals Florida as the historically dominant supplier from November to January and again from April to May. In contrast, Mexico (Sinaloa) is the largest supplier in February and March. Therefore, February and March represents the most intense period of the Florida-Mexico competition. In June to November the primary supply area shifts to other states (mainly California), followed by Florida and then Mexico (Baja California).

Shipments from California rise substantially in June and peak in October. Shipments from Baja California peaked during June to July. Baja California provided a relatively small

Table 4. Distribution of apparent United States fresh tomato consumption by season and Suppliers 1978 to 1996

Seasons and years	FLSH*	MXSH*	ODSH*	OISH*	MX&FL*
	-----------Shares in percentages-----------				
Winter : January to March					
1978	30.17	69.55	0.18	0.10	99.72
1979	49.35	50.40	0.12	0.14	99.74
1980	53.18	46.12	0.58	0.12	99.30
1981	56.44	40.54	2.45	0.56	96.98
1982	54.45	43.86	1.59	0.09	98.32
1983	58.17	41.02	0.52	0.29	99.18
1984	57.60	41.74	0.39	0.27	99.34
1985	45.47	53.80	0.55	0.18	99.27
1986	64.99	32.58	0.55	1.88	97.57
1987	33.03	36.65	29.47	0.84	69.68
1988	57.41	39.87	2.32	0.40	97.29
1989	53.53	38.98	2.03	5.87	92.51
1990	21.11	59.82	0.86	18.21	80.93
1991	45.77	36.92	15.77	1.53	82.69
1992	72.95	21.91	4.80	0.33	94.86
1993	52.46	45.29	2.14	0.11	97.74
1994	51.17	47.27	1.47	0.09	98.44
1995	49.77	49.48	0.41	0.34	99.25
1996	44.34	54.67	0.38	0.61	99.01
Mean	50.07	44.76	3.50	1.68	94.83
Max.	72.95	69.55	29.47	18.21	99.74
Min.	21.11	21.91	0.12	0.09	69.68

Table 4.--Continued					
Seasons and years	FLSH	MXSH	ODSH	OISH	MX&FL
	----------------Percentages----------------				
Spring: April to June					
1978	37.42	38.28	24.07	0.22	75.70
1979	42.14	33.15	24.55	0.16	75.29
1980	49.75	34.51	15.65	0.08	84.26
1981	61.95	13.18	24.59	0.28	75.13
1982	50.72	25.14	24.10	0.04	75.86
1983	52.67	36.16	11.08	0.09	88.83
1984	50.56	25.44	23.84	0.17	75.99
1985	44.16	23.11	32.32	0.41	67.27
1986	44.81	34.89	19.06	1.24	79.69
1987	49.13	20.82	29.46	0.60	69.95
1988	64.42	16.81	18.16	0.61	81.23
1989	21.03	7.26	5.73	65.99	28.28
1990	36.38	6.03	10.64	46.95	42.41
1991	13.55	7.51	23.41	55.53	21.06
1992	68.98	10.30	19.82	0.90	79.28
1993	59.53	22.23	16.87	1.36	81.76
1994	55.43	18.87	24.30	1.41	74.30
1995	57.50	21.73	17.96	2.81	79.23
1996	54.73	28.60	13.64	3.03	83.33
Mean	48.15	22.32	19.96	9.57	70.47
Max.	68.98	38.28	32.32	65.99	88.83
Min.	13.55	6.03	5.73	0.04	21.06

Table 4.-- Continued					
Seasons and Years	FLSH	MXSH	ODSH	OISH	MX&FL
	----------------Percentages----------------				
Summer: July to September					
1978	0.12	6.13	93.63	0.12	6.25
1979	0.12	8.58	91.15	0.15	8.70
1980	0.20	3.07	96.63	0.10	3.27
1981	0.09	33.54	66.29	0.08	33.64
1982	0.09	6.10	93.63	0.18	6.19
1983	1.20	7.07	91.63	0.10	8.27
1984	0.75	10.84	88.10	0.31	11.59
1985	0.05	14.89	84.79	0.28	14.94
1986	0.10	15.96	83.63	0.31	16.06
1987	0.32	13.85	85.49	0.34	14.17
1988	0.31	21.10	78.19	0.40	21.42
1989	0.08	5.69	25.37	68.85	5.78
1990	0.57	5.09	29.86	64.47	5.66
1991	0.00	4.12	34.28	61.60	4.12
1992	4.97	11.42	82.82	0.79	16.39
1993	1.05	11.05	86.95	0.94	12.11
1994	1.05	19.01	77.20	2.74	20.05
1995	1.35	34.78	57.13	6.74	36.13
Mean	0.69	12.91	74.82	11.58	13.60
Max.	4.97	34.78	96.63	68.85	36.13
Min.	0.00	3.07	25.37	0.08	3.27

Table 4. --Continued					
Seasons and years	FLSH	MXSH	ODSH	OISH	MX&FL
	---------------Percentages---------------				
Fall: October to December					
1978	49.80	8.23	41.94	0.03	58.03
1979	48.63	8.01	43.34	0.02	56.65
1980	49.48	4.72	45.77	0.03	54.20
1981	47.85	2.84	49.30	0.01	50.68
1982	46.39	10.40	43.17	0.04	56.79
1983	48.51	15.10	36.34	0.05	63.61
1984	58.79	11.24	29.91	0.06	70.03
1985	40.99	15.17	43.73	0.10	56.17
1986	51.10	17.38	31.35	0.17	68.48
1987	49.23	14.49	36.16	0.12	63.72
1988	54.64	10.17	35.07	0.11	64.82
1989	34.58	12.17	17.09	36.16	46.75
1990	41.37	9.08	22.47	27.08	50.45
1991	29.31	6.69	42.42	21.58	36.01
1992	57.51	10.72	31.36	0.40	68.23
1993	51.71	17.33	30.43	0.54	69.04
1994	54.00	15.92	29.17	0.91	69.92
1995	39.65	27.07	31.45	1.83	66.72
Mean	47.42	12.04	35.58	4.96	59.46
Max.	58.79	27.07	49.30	36.16	70.03
Min.	29.31	2.84	17.09	0.01	36.01
Overall Mean	36.58	23.01	33.47	6.95	59.59

* indicates the share of apparent domestic consumption accounted for by Florida (FLSH), Mexico (MXSH), Other domestic states (ODSH), Other foreign suppliers (OISH) and Mexico and Florida combined (MX&FL).

Source: Author's Calculations based on data from (i) Annual Reports of The Florida Tomato Committee; (ii) Fresh Fruit and Vegetable Shipments: By Commodities, States and Month, USDA and; (iii) United States Import History by Commodities and Origin, Bureau of Census, United States Department of Commerce.

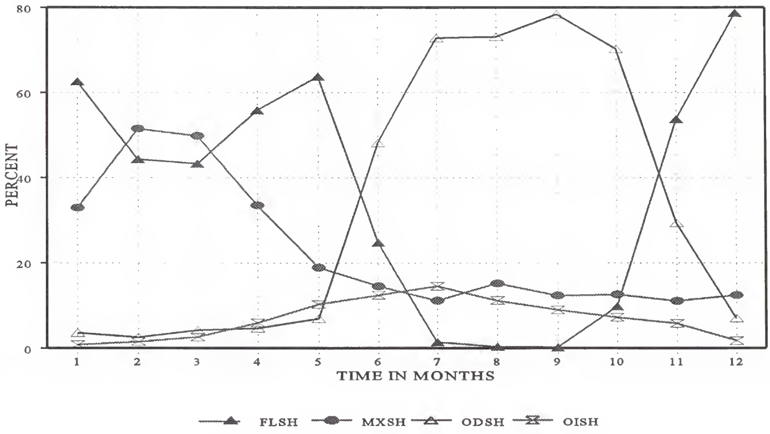

Figure 2. Mean Monthly Fresh Tomato Market Share Distribution

but constant supply of fresh tomatoes from August through December, tapering off in January. Fresh tomatoes are commercially available from other states primarily June through October (USITC, 1996). In 1995, for example, Georgia and Virginia accounted for 6 and 4 percent, respectively. Tennessee, New Jersey, and South Carolina supplied 2 percent each.

Market shares for Mexico in 1994, 1995 and 1996 relative to the long term means have been increasing. For the winter period Mexico's share increased 11 and 22 percent for 1995 and 1996, respectively. For the corresponding period Florida's share declined by 3 and 11 percent, respectively. During the summers of 1994 and 1995 Mexico's shares increased 47 and 169 percent, respectively. The latter represents the highest gain for the 19 years covered by the data. For the fall of 1994 and 1995 Mexican share increased 32 and 125 percent, respectively. The latter represents the highest increase for the years covered by the data. For corresponding period Florida's share increased 14 percent in 1994, but declined 17 percent in 1995.

An estimated 90 percent of Mexican fresh tomatoes exports to the United States are vine-ripe, common round types. In contrast, Florida and California supply mainly mature-green, common round types. Vine-ripe cherry and roma tomatoes from Mexico have been increasing in recent years. Sizeable acreage are devoted to producing roma tomatoes in Florida. However, growers in Florida have not diversified into producing roma and cherry tomatoes as heavily as their Mexican counterparts.

Per capita consumption of fresh tomatoes in the United States over the period 1980-90 averaged approximately 17.6 pounds (Organization for Economic Co-operation and Development, 1992). Industry analysts suggest that growth in per capita consumption of

fresh tomatoes has been slower than the growth in supply, resulting in a surplus which has depressed real prices.

Economic and Institutional Characteristics

Commercial production of fresh tomatoes in Florida was undertaken by approximately 200 growers in 1991 in the areas regulated by the Federal Marketing Order (VanSickle et al., 1994). Recently the 13 largest Florida growers (averaging approximately 900 acres per farm) have accounted for more than 25 percent of production. A decade ago the 60 largest growers produced 60 percent of the crop (Bredahl et al., 1983). An estimated 30 packing firms handle about 97 percent of all tomato packing in Florida (VanSickle et al., 1994).

Fresh tomato production in Mexico, like Florida, is concentrated on a few large farms. In 1980 about 50 percent of exports to the United States were produced by 12 large growers ranging from 700 to 3500 acres. Within this group there is evidence of vertical integration. For example, some large growers own trucking lines which transport tomatoes to Nogales. Several also own and operate distribution firms in Nogales (Bredahl et al., 1983). Emerson (1980) estimated that about 1100 small farms ranging from 25 to 250 acres participated in the export industry. Typically small growers are members of cooperatives which provide production and marketing services.

Sinaloa, Sonora, and Baja California account for 75 to 90 percent of Mexican tomato exports to the United States. The hot, dry climate which characterizes these areas favors horticultural production in the fall, winter and spring seasons. The summer is generally too hot for vegetable production in Sinaloa and Sonora. With the exception of limited export

volumes out of Baja California, domestic producers are largely protected from Mexican competition in the summer by climatic factors. Sinaloa exports tomatoes to the United States December through June via Nogales, Arizona, with peak shipments during January to March. Mexican-owned firms account for most of Sinaloa's production, only a few United States owned firms operate in this region (Love and Lucier, 1996). Baja California producers export to the United States mainly in June to December (Plunkett, 1996). United States owned firms invest heavily in this region (Love and Lucier, 1996).

Most Florida growers have an established relationship with one of more than 80 registered tomato handlers or packers. Packers contract with growers to pack, transport and sell their tomatoes in the domestic market. The size of packers varies, but most handle tomatoes for several growers in their area. Many are re-packers of tomatoes or handle relatively small amounts. An estimated 30 packers handle 97 percent of the fresh tomatoes sold in the national marketing system (VanSickle et al., 1994).

About 75 marketing agents are registered members of the West Mexico Vegetable Distributors Association (WMVDA). Firms handling mature-green and cherry tomatoes are highly concentrated with four firms handling 77 and 68 percent of Mexican shipments for each tomato type (VanSickle et al., 1994; USITC, 1996).

A wide range of organizations provide services to growers and marketing agents. In Florida, these include the Florida Tomato Committee (FTC), Florida Tomato Growers Exchange (FTGE), Florida Tomato Exchange (FTE), Florida Fruit and Vegetable Association (FFVA) and Florida Farm Bureau (FFB).

The FTC is responsible for implementing the Federal Marketing Order (No. 966) for tomatoes. This Order covers most tomatoes grown in Florida as well as all tomato imports during the regulated season (October to June). Each season the FTC recommends to the USDA fruit size, grade, container, packaging, and inspection requirements for tomatoes. Once these recommendations are approved by the USDA they are binding on all tomato growers and handlers in south and central Florida. Tomatoes imported into the United States during the regulated season must conform to the approved minimum size and grade regulations. Amendments to the FMO in 1986 gave the FTC additional responsibilities for conducting production research, education and promotion programs for the industry.

The FTGE was organized in 1989, as a cooperative of growers in central and south Florida to coordinate activities for the orderly marketing and distribution of fresh tomatoes. Excess supplies experienced in the spring of 1990 prompted the Exchange to implement minimum prices and shipping holidays. These price enhancing actions led to the resignation of some members from the Exchange. The FTGE was reorganized in 1990 and its activities restricted to marketing and membership issues. Its current members account for about 85 percent of production in central and south Florida.

The FTE is a state-wide cooperative of first handlers, providing collective action for the orderly marketing and distribution of Florida's fresh tomatoes. Most of its programs are those not permitted by the FMO which governs the FTC. Major activities of the FTE include lobbying efforts and retaining legal aid for assistance on issues affecting the Florida industry. Basic public relations activities also fall under the auspices of the FTE.

The FFVA is a cooperative association of growers, shippers, packers and processors. The organization sponsors labor programs to minimize seasonal labor shortages and help maintain a legal workforce. It is also instrumental in assisting growers to develop cooperative marketing strategies and in solving specific production problems. The FFVA is a major player in state, national and international policy discussions that affect the fruit and vegetable sector. It keeps producers and shippers aware of policy that may affect them and lobbies for policy changes on issues adversely affecting its members.

The FFB is a cooperative organization of producers of food and fibre. Its major role in the vegetable industry is assisting growers in formulating and implementing legislative agendas pertinent to the industry.

Production and marketing of fresh vegetables for export in Mexico are coordinated through local, state and national cooperative associations. The National Confederation of Horticultural Producers (CNPH) consists of grower associations from different states or regions in Mexico, each of which is comprised of local producer associations. The most important member of the CNPH is the Confederation of Agricultural Associations for the State of Sinaloa (CAADES).

CAADES is the most powerful state organization given the concentration of the fresh vegetable industry in that state. It negotiates on behalf of growers with state and federal governments, conducts residue testing, farm extension, scientific experiments, quality inspections, and weather forecasting. Two recent voluntary measures taken by CAADES growers illustrate their organizational power. First, they agreed to raise quality standard, so that tomatoes shipped to the United States would be 90 percent or more of the United States

No.1 grade. Secondly, they reportedly halted shipments to the United States market for two consecutive days (march 2 and 3, 1996) and Florida prices increased (Plunkett, 1996).

More recently, CAADES collaborated with the Volcanic Institute of Israel to develop the ESL varieties. Given the limited involvement of the Mexican government in research and development, CAADES fulfills many of the functions that government agencies, marketing boards, or land grant universities perform in the United States. About 90 percent of the tomatoes produced in Sinaloa are grown by CAADES members (Plunkett, 1996). Mexico's export production is very capital-intensive, involving drip irrigation, fertigation, plastic mulch, planed stakes, and ESL varieties. This package of technology, excluding ESL varieties, were transferred from the United States to Mexico with the help of domestic marketing agents.

Marketing Channels and Pricing Practices

Domestic and imported tomatoes, both mature-green and vine-ripe, are sold through the same distribution channels. Fresh tomatoes in the domestic industry are moved from field to packing house for grading, packaging and transported to wholesale and terminal markets where they are sold through intermediaries to distributors, retailers, or food brokers.

Similarly, fresh tomatoes in Mexico are moved from field to packing house where they are graded, packed, and transported by trucks principally to Nogales, Arizona for sale through importers and brokers. Mexican tomatoes are inspected by several Mexican and United States agencies to ensure compliance with domestic market requirements. At present, Mexican truckers must off-load tomatoes at the distributors' storage sheds after which the distributors enter the produce into the domestic marketing system.

Fresh tomatoes, like most other vegetables, are sold over the telephone by contractual agreements between shipping point operators and wholesale buyers in the United States markets. These agreements, although generally not written (USITC, 1996), facilitate shipping logistics and help assure markets for highly perishable vegetables. Market integrity is maintained by long established trading customs, trade ethics, and trade laws, such as the Perishable Agricultural Commodities Act (PACA).

Impacts of Exchange Rates and Macroeconomic Changes

Peso devaluation is equivalent to a tariff on Mexican imports and a subsidy on its exports. For a given level of tariffs, a country can change the protection level on agricultural goods by maintaining an over- or undervalued currency. An overvalued peso benefits domestic exports to Mexico, but penalizes Mexican exports to the United States, the converse is also true. Tariffs are commodity specific, while devaluation applies to all commodities or markets. Exchange rate policy, therefore, exerts greater impacts on economies relative to commodity-specific policies such as price controls, tariffs or subsidies (Krueger et al., 1988; Shane, 1990). Changes in exchange rate and trade policy have influenced the United States fresh vegetable market in several significant ways. The Mexican government drastically reduced or eliminated subsidies on fertilizer, water, electricity, fuel and other agricultural inputs. This induced substantially higher costs for Mexican growers. Agricultural rates for electricity were increased 130 percent in 1990 and some irrigation districts were removed from government administration (Segarra, 1992). Mexican growers are being incorporated into the federal tax regime, subjecting them to income taxes for the first time.

Elimination of federal subsidies on electricity and fuels may have greater economic impact in Baja California and Northern Sonora because their irrigation water is obtained from deep wells. Sinaloa and Southern Sonora are affected less because their irrigation water is mostly from surface sources. Upward adjustments in fertilizer prices combined with higher electricity and fuel costs are likely to bring about reallocation of irrigated lands from lower to higher valued crops such as fruits and vegetables (Thompson and Hillman, 1989; VanSickle et al., 1994). Such a development might intensify the competition between Mexico and the United States fresh tomato producers in the domestic market.

More liberal trade rules and competitive devaluations directly influence prices farmers receive for exports and prices paid for inputs. In the short to medium term peso-dollar devaluations increase the peso price farmers receive for tomato exports. This short run price effect enhances the profitability of producing for export and may generate a positive supply response. Mexican fresh tomato exports are dependent on United States inputs, including chemicals, fertilizers, seed varieties, transplants, boxes, plastics, fumigants, farm machinery, packing house equipment, and drip irrigation materials. These inputs cost more after peso devaluation. Further, these inputs are more expensive to Mexican growers because of transportation and border crossing costs and Mexican import duties (ranging from 10-20 percent). Import duties will be phased out under NAFTA, hence, over time the cost of these inputs in Mexico should decrease and become closer to those in the United States. In the interim, labor may be Mexico's primary cost advantage.

Lower labor rates are often cited as crucial to Mexican tomato exporters ability to compete in the United States. In 1991, field labor in Mexico cost from $4 to $10 per day,

depending on the crop and region. In comparison, average labor rates in the United States ranged from about $4 to $6 per hour. However, labor is frequently less productive in Mexico due to restrictive work rules and less intensive management. Harvesting and packing costs are always less in Mexico due to lower wages and the labor-intensiveness of these tasks. But other production operations are generally not as labor-intensive, and not necessarily cheaper, because technology which substitute chemical and mechanical inputs for labor are available.

Although peso devaluation caused Mexican costs of production to rise in peso terms, in dollar terms those costs actually fell because inflation in wages and other domestic input prices lagged behind the rate of devaluation. For example, because of high unemployment, the cost of field preparation and harvesting were down by about 50 percent in dollar terms (Plunkett, 1996). For imported inputs such as planting and transplanting material, dollar costs went up by about 23 percent (Plunkett, 1996). More than a third of the cost of producing tomatoes is labor and management, paid for mostly in pesos. Therefore, in dollar terms, reduced wages and the lower cost for domestically produced inputs resulted in lower overall production costs in Mexico compared to the United States.

The NAFTA Implementation Act (Section 316) provides special safeguards for fresh tomatoes produced in the United States. In particular, beginning in 1994 tariff-rate quotas (TRQs) were imposed in the United States market, 172,300 metric tons for the market period November 15 to the end of February and 165,500 metric tons for the period from March 1 to July 14. These TRQs increase by 3 percent each year until the end of the 10-year transition period when they are removed. The initial import tariff rates corresponding to these periods

were 4.6 and 3.3 cents per kg, respectively. For shipments exceeding these levels, the most favored nation (MFN) tariff rate is applied.

Industry analysts have argued that upward trends in vegetable prices have significantly reduced the restrictive effect of import tariffs (Bredahl et al., 1987). For example, from 1974 to 1979, the ad valorem equivalent duty on tomatoes decreased from 17 to 8.5 percent (Zepp, 1982). In other words, pre-NAFTA tariffs on imported tomatoes have been too low for its reduction under NAFTA to have a significant impact on Mexico's ability to compete with Florida (VanSickle, 1996). Cost and revenue comparisons between Sinaloa and Florida indicate that the cost advantage to Mexico if the tariff on tomatoes were eliminated immediately is significantly less than the price premium received by Florida producers. One implication of this is that it may be more important for Mexico to focus on activities which increase yields and quality than to rely on benefits of tariff elimination. It appears that this is the approach they have taken with ESL varieties.

Cross-border transportation of vegetables was to be permitted under NAFTA, this would eliminate the need for off-loading of Mexican produce at the border. If the provisions are implemented transaction costs could fall and damage to produce resulting from extra handling minimized; thus, Mexico may gain market share because of these changes.

Privatization of the financial sector will alter its structure and mode of operation. The system may become more efficient in terms of lowering costs and increasing access to capital. This could modify existing contractual relationships between producers and marketing agents because most of the working capital in the vegetable sub-sector in Sinaloa, Sonora, and Baja

California is provided by United States growers, packers, shippers, and distributors (Thompson and Hillman, 1989).

Fundamental changes in the land market have resulted from ejido reforms. Prior to the reforms, nearly 50 percent of the irrigated lands in Sinaloa and Sonora were legally under the ejido system (Firch and Young, 1968). Accordingly, all land transactions between ejidos and private owners were illegal. Reforms allow ejidos to rent, lease or sell their lands. This is expected to lower land prices in response to greater marketable supply. In addition, reforms now permit foreigners to own land subject to legal restrictions on the maximum size of holdings. Foreign investment in agriculture and agribusiness through joint ventures are being promoted. These land related changes could lead to more efficient farm size, thereby intensifying the United State-Mexico competition.

Florida growers encounter many regulations which constrain profitability. These include minimum wages, occupational safety and health regulations, environmental protection agency restrictions which affect availability and use of pesticides, state and local government regulations regarding water quality, and USDA marketing orders pertaining to product characteristics. The implication is that these regulations may become excessive in Florida relative to Mexico and cause Mexican production to expand more rapidly.

In summary, the Mexican unilateral reforms combined with the NAFTA are expected to yield positive economic results in terms of increases in aggregate bilateral trade flows, direct investment flows, productivity growth, economic efficiency, and reduced trade related costs. In particular, constitutional reforms have encouraged investment in agriculture which may significantly narrow the technology gap between Mexico and the United States, thereby

augmenting Mexico's ability to compete. The structural changes in Mexico's land tenure system and agricultural investment policy may be as important as NAFTA in the future capacity of Mexico to compete with Florida in the domestic market for fresh tomatoes.

NAFTA has generated a serious debate regarding the advantages and disadvantages of the agreement for the United States horticulture industry. Supporters of NAFTA argue that through specialization, competition, and economies of scale, the agreement will increase economic efficiency and welfare of participants as a group.

NAFTA opponents, however, are interested not only in increased benefits, but in their distribution. The main concern is that NAFTA may decrease low-skilled wages in the United States because Mexican exports are intensive in low skilled labor. This proposition has been countered by suggestions that the relative size of the United States and Mexican economies and NAFTA's long phase in means that this Stolper-Samuelson effect will be small, and will be swamped by other growth generating effects (Hinojosa-Ojeda and Robinson, 1992). NAFTA is also expected to shift resources from less competitive to more competitive sectors. According to Hecksher-Olin-Samuelson analysis, sectors that will prove most competitive and therefore gain most from NAFTA will be those that use relatively abundant factors most intensively. Most studies suggest that the fruit and vegetable sectors in the United States will be the main losers (Gruben and Welch, 1994).

Peso appreciation, decreased input subsidies, increasing taxation and stabilized demand in the United States fresh tomato market has impaired the ability of Mexican tomato exports to compete with Florida. On the other hand, a depreciating peso provided added incentives for Mexico to increase exports to the United States (Plunkett, 1996). While

Mexico has an advantage in lower labor rates, labor is less efficient and yields are frequently lower, partially offsetting this advantage. Although horticultural production is intensive in labor, technology and management are also important and the United States holds the advantage in these areas.

Weather and the peso-dollar exchange rate are two short run factors minimizing Florida's ability to compete with Mexico in the United States market for fresh tomatoes. These short run factors are beyond the direct control of Florida producers. In contrast, yield, quality improvements and production costs are more directly under their control.

CHAPTER 3

LITERATURE REVIEW

The relationship between exchange rates, prices and agricultural trade flows has been a major topic of research over the past 25 years. In a seminal paper, Schuh (1974) attributed rapid growth of United States agricultural exports to devaluation of the dollar. In contrast, contraction in agricultural exports was blamed on appreciation of the dollar. The connection between exchange rates and agricultural trade has been well documented (Alston et al., 1992; Grennes, 1990; Goodwin et al., 1990). However, consensus is lacking in terms of magnitude of the exchange rate impact. Some economists view exchange rates as the single most important variable influencing the economic environment for agricultural trade (e.g., Shane, 1990). Some concluded that exchange rate movements alter trade volumes (Chambers and Just, 1981), others have found that they do not (Johnson et al., 1977).

Mexican fresh tomato export production is geared almost exclusively for the United States market. Accordingly, how import prices and import shares adjust to movements in the peso-dollar exchange rate is extremely important for policy.

The structure of this chapter is as follows, section (2) provides alternate definitions of the exchange rate pass-through phenomenon. Section (3) reviews the mainstream theoretical and empirical models of exchange rate pass-through. Section (4) focuses on models of market share determination. Section (5) highlights some major issues in estimating

exchange rate pass-through. Section (6) summarizes the review in the context of guidelines it offers in formulating a suitable theoretical and empirical model for the problem at hand.

Definitions of Exchange Rate Pass-through

Exchange rate pass-through measures the responsiveness of import or export prices to changes in exchange rates (Kholsa and Teranishi, 1989; Arestis and Milberg, 1993; Alston et al., 1992; Athukorala and Menon, 1994; Menon, 1994; Wilamoski, 1994). The terms exchange rate pass-through, transmission, impact and pass-through are used interchangeably. Dwyer et al., (1994) defines pass-through as the process by which changes in the exchange rate impact prices of traded goods. This definition conveys the notion that price adjustments to movements in exchange rates is a time consuming process.

Interest in exchange rate pass-through developed from the "elasticities approach" to estimate import and export demand functions in international trade. Branson (1972) and Menon (1995a) derive the expression for exchange rate pass-through (λ^p) based on the elasticities approach as

$$\lambda^p = \left(\frac{dP^D}{P^D}\right)\left(\frac{dER}{ER}\right)^{-1} = \left(1 - \frac{\varepsilon_D}{\eta_s}\right)^{-1} \tag{1}$$

This formula makes it clear that pass-through is a function of the elasticities of import demand (ε_D) and supply (η_S). If supply or demand for imports is perfectly elastic (inelastic), pass-through is complete (zero). The main disadvantage of estimating pass-through from equation (1) is that it sheds no light on the dynamics of price response to exchange rate adjustments (Menon, 1995a). Direct estimation of exchange rate pass-through overcomes this problem, particularly when high frequency data are available.

The alternate definition of pass-through, which is employed throughout this study, relates percentage change in domestic import prices to percentage change in exchange rate in the form of an elasticity. In a theoretical sense, the percentage change in import price can be greater than or less than the percentage change in exchange rate. The exchange rate pass-through (λ^P) is defined mathematically as

$$\lambda^P \equiv \frac{\partial P}{\partial E}\frac{E}{P} \overset{\leq}{\geq} -1 \qquad (2)$$

where E is the exchange rate (importer currency per unit of exporter currency) and P is the domestic currency import price. By convention, when equation (2) holds with strict equality, pass-through is said to be complete. If it is greater (less) than -1, pass-through is incomplete (more than complete).

The concept of exchange rate being passed-through to domestic prices has been explained in a number of different ways in the international trade literature. Branson (1972) defined full or complete pass-through of an exchange rate depreciation as a situation in which the price index for imports in the currency of the depreciating country should be rising substantially, while in countries with appreciating currency the price index should be falling.

Mainstream Explanations of Exchange Rate Pass-through

The theoretical and empirical literature on exchange rate pass-through has relied on the law of one price (LOP) and industrial organization (IO) frameworks. The substantive theoretical foundations and examples of empirical implementation associated with each approach are sketched below.

Law of One Price Models

The law of one price (LOP) relates exchange rates to the prices of individual homogeneous goods in different countries. It is the most widely applied method of measuring exchange rate pass-through to import or export prices. LOP posits that if there are no transaction costs or trade barriers, prices of traded homogeneous goods should be the same in domestic and foreign economies when expressed in a common currency. The LOP can be expressed symbolically as

$$P^D = P^F \,.\, E \tag{3}$$

where P^D is the domestic price of the good, P^F is the corresponding foreign price, and E is the nominal exchange rate in units of domestic currency per unit of foreign currency. An increase in E indicates foreign currency devaluation, or domestic currency appreciation. Conversely, a fall in E indicates foreign currency (peso) appreciation, or dollar depreciation. Departure from the LOP occurs when, for a given foreign price of the traded good, changes in its domestic price are not proportional to changes in the exchange rate. In other words, deviation from LOP occurs when exchange rate pass-through is incomplete.

The LOP stated in equation (3) is restrictive, because it requires the exchange rate at a given point in time to be equal to the ratio of prevailing prices. The actual exchange rate, however, may deviate from the purchasing power parity (PPP) rate due to imperfections of published price data (i.e., prices in different countries may not reflect the cost of identical commodities). To avoid these problems, equation (3) is sometimes written as percent change instead of levels. This gives the weak or relative version of LOP as

$$e = p^d - p^f \tag{4}$$

where $e = \ln(E_t - E_{t-1})$, $p^d = \ln(P^D_t - P^D_{t-1})$, $p^f = \ln(P^f_t - P^f_{t-1})$ and ln denotes the natural

logarithm. Equation (4) requires that the percentage change in the exchange rate be equal to the inflation differential in the two countries. The exchange rate, accordingly, will depreciate (appreciate) if inflation rate in the domestic market is greater (smaller) than that in the foreign market.

LOP represents the core of perfectly competitive models of supply and demand in the international trade literature. In this model, domestic import price falls in proportion to the exchange rate depreciation only if the importing country is small relative to the rest of the world. If the importing country is large, a reduction in domestic import prices caused by depreciation of exporter currency will increase demand in the importing country and raise foreign currency prices. Under these circumstances the net decline in dollar price will be less than proportional to the exchange rate change.

The empirical literature on exchange rate pass-through has focussed on incorporating some variant of equation (4) into a larger model depending on the hypotheses to be tested and other variables considered to influence pass-through. A typical LOP empirical model for evaluating pass-through is

$$P_t = \alpha + \sum_{i=0}^{n} \beta_i \, e_{t-i} + \mu_t \qquad (5)$$

where P_t is the logarithm of import price in terms of importer currency, e_t is the logarithm of the exchange rate, n is the maximum number of lags on the exchange rate and μ_t represents residual factors. Estimation of (5) by ordinary least squares (OLS) provides unbiased estimates of the pass-through effect. In a market exhibiting competitive behavior and perfect arbitrage, the true parameter values are $\alpha=0$ and $\sum\beta_i=1$. The pass-through elasticity is the sum of the lagged coefficients on the exchange rate. The degree of price adjustment to

changes in the exchange rate will be reflected by the pattern of the β_is. The lagged response of prices to exchange rate adjustments could result from production or delivery lags. Also, depending on the larger model in which (5) is couched, the β_is could indicate the impact of endogenous changes such as market structure or the strategic pricing by foreign suppliers.

Jabara and Schwartz (1987) studied pass-through of United States exchange rate movements on Japanese domestic prices of beef, corn, cotton, soybeans and wheat. Their test of the ratchet hypothesis revealed full passed-through to Japanese prices when the dollar depreciated, but only limited pass-through occurred when the dollar appreciated.

Dwyer et al. (1994) estimated exchange rate pass-through to prices of imports and exports of Australian manufactured goods. They used quarterly data, cointegration and error correction modeling (ECM) to estimate long and short run pass-through. Their results indicated complete long run pass-through to import and export prices. The residuals from their estimation, which represents deviations from long run equilibrium, were used in an error correction (ECM) framework to analyze the dynamics of adjustment towards the long run equilibrium. The estimates from this procedure showed that in response to a 1.0 percent depreciation, import prices rose by about 0.5 percent in the same quarter in which the devaluation occurred. After one quarter, import prices rise by about 0.8 percent. It took roughly four quarters before the impact of the depreciation was complete. Pass-through of world prices (foreign prices) was completed in three quarters. In contrast, for a 1.0 percent depreciation, export prices rose by 0.3 percent in the same quarter as the devaluation. After four quarters export prices rose only 0.65 percent. It took almost eight quarters to achieve complete passed-through to export prices.

Baharumshah and Habibullah (1993) investigated exchange rate pass-through both as short and long run relationships. Their empirical applications were to international markets for rubber, palm oil, cocoa, and timber. Monthly data were used for rubber, palm oil, and timber. Quarterly data were used for cocoa. Optimum lag length, using Akaike's (1969) final prediction error (FPE), were 15, 12, and 17 months for palm oil, rubber, and timber, respectively; and 3 quarters for cocoa. For the current month (short run), the results indicate that a 1.0 percent depreciation in the Malaysian currency resulted in 0.006, 0.006 and 0.46 percentage changes in export prices for palm oil, rubber and timber, respectively. Short run pass-through in the current quarter was 0.27 for cocoa. In general, the long run exchange rate pass-through elasticities were found to be less than unity. Specifically, following a 1 percent devaluation of the Malaysian currency the long run passed-through to export prices were only 0.18, 0.24, and 0.48 percent for timber, palm oil, and rubber, respectively; for cocoa it was 0.63 percent. These results imply that it is possible for Malaysia to engage in incomplete pass-through to protect its market share, especially when faced with an appreciating currency. Furthermore, the results offer no support for LOP even in the long run. The authors speculated that possible reasons for incomplete long run pass-through include imperfectly competitive markets, imperfect substitutability of products, sluggishness of international arbitrage and the presence of tariff and non-tariff barriers.

Goodwin et al. (1990) formulated a rational expectations augmented LOP model and applied it to international markets for United States wheat, oilseed products, corn and grain sorghum. This approach provided strong support for the LOP, in contrast to formulations using contemporaneous prices. Goodwin (1992) investigated exchange rate pass-through to

five international markets for United States wheat. He found that the LOP as a long run equilibrium concept failed when transportation costs were excluded. However, after adjusting prices for freight rates the LOP was fully supported. Baffes (1991) included stationarity and cointegration techniques and transportation costs in his study of pass-through for seven agricultural commodities to four markets. In general, his results supported those of Goodwin (1992). By contrast, Ardeni (1989) tested LOP using cointegration and reported that in most cases the LOP failed as a long run relationship in several agricultural markets.

This selective sample of LOP studies are not inconsistent with the findings of Officer (1990) who reviewed 40 similar studies and concluded that 28 rejected LOP, 8 had mixed findings, and only 4 could not unambiguously reject LOP. The above results clearly suggest that the variables included, econometric techniques employed, structure of the commodity markets, frequency of data, the period covered and definition of the exchange rate might have contributed to the mixed results obtained.

In general, three factors contribute to deviations from the LOP (Melvin, 1992). First, transport costs and barriers to trade such as tariff may lead to permanent deviation. Second, different speeds of adjustment in the exchange rate and goods markets may lead to temporary deviation. Similarly, deviations may also occur if there are changes in relative prices due to real economic events (such as changes in tastes, technology, government policies, and weather conditions), even if exchange rates and goods prices do not vary at different speeds. Third, quality differences among goods and comparisons of prices at the time of order with exchange rates at the time of delivery may contribute to permanent deviation from LOP.

Industrial Organization Models

The LOP may be unsuitable for analyzing the impact of Mexican exchange rate changes on the United States market for fresh tomatoes, if either the Mexican or the Florida industry exercise market power (Alston et al., 1992). This can be demonstrated using the framework of Hooper and Mann(1989). Let the price of a traded good be the sum of its costs of production (c) and a profit margin (m), then

$$p^f = c^f + m^f \tag{6}$$

$$p^d = c^f + m^f + e \tag{7}$$

Equation (7) is obtained by substituting (6) into (4) and rearranging. This expression indicates that changes in the domestic import price of traded goods is influenced by exchange rate (e) and the pricing strategies of foreign firms (m). Under perfect competition (m^f=0) domestic import price will change to the full extent of the exchange rate because individual firms have no market power and competition prevents strategic behavior. With noncompetitive market structures ($m^f \neq 0$) foreign profit margins may vary and domestic prices will generally not reflect the full extent of exchange rate fluctuations. In these circumstances, foreign suppliers may offset the effects of depreciation by reducing profit margins (m), resulting in incomplete exchange rate pass-through. Hooper and Mann (1989) further show that pass-through should allow for variation in profit margins of both domestic and foreign price setting firms, i.e.

$$c^d + m^d = c^f + m^f + e \tag{8}$$

It is obvious from equation (8) that exchange rate pass-through may occur in two stages. In the first stage, foreign price setting agents will choose either to maintain or change their profit margin in response to a depreciation. In the second stage, domestic importers may choose to maintain or change their margins when they decide what price to charge their customers.

Therefore, the final impact of an exchange rate depreciation on consumer prices is determined by the combined pass-through.

Recent work based on industrial organization (IO), in contrast to LOP, allows for complete and incomplete exchange rate pass-through. The typical industrial organization approach to pass-through assumes imperfect competition, and strategic interactions between domestic and foreign firms in their decisions regarding price or quantity. Three groups of theoretical and empirical models have dominated this literature, namely, oligopoly, pricing to market (PTM), and Hysteresis or path-dependent.

Models of Oligopolistic Competition

Morkre (1993) provided a theoretical oligopoly model where optimum quantities (and prices) depend on conjectural variations. Conjectures reflect degrees of rivalry between domestic and foreign firms. Perfect competition is one extreme where perceived rivalry is so intense that firms believe they cannot influence price. However, as the intensity of rivalry decreases, firms believe they can influence price by reducing sales. This model was employed to examine the impacts of foreign subsidy under five forms of competition. The theoretical results in terms of degree of rivalry (ranked from highest to lowest), or in terms of perceived influence over price (ranked from lowest to highest) were perfect competition, Bertrand, consistent (Stackleberg) conjecture, Cournot, and collusion. Foreign subsidies were found to be fully passed-through to domestic import price under perfect competition. Under Bertrand and other forms of oligopoly competition, pass-through of foreign subsidy was progressively smaller as the intensity of rivalry diminished. This model is appropriate for

studying exchange rate pass-through since an undervalued exchange rate is an implicit export subsidy, whereas an overvalued exchange rate is an implicit export tax.

Feenstra (1989) developed an oligopoly model similar to Morkre's and applied it to evaluate exchange rate and tariff pass-through. Feenstra considered the case where foreign and domestic firms act as Bertrand competitors, and the foreign firm sets its price in the domestic currency. The main results in terms of comparative statics are elaborated given their importance to the current study. First, the elasticity of domestic import price to a change in the expected exchange rate [$\lambda^e = (dp/de)(e/p) < -1$] is expected to be less than fully passed-through. However, it is determined by demand and cost structure. If demand is linear, less than complete pass-through occurs and import prices will change to an extent less than the change in expected exchange rate. As demand becomes more elastic, other things remaining constant, the value of the exchange rate elasticity converges to zero. In the limiting case where the firm has no influence over import price (price taker), the exchange rate elasticity is zero. Thus there is no pass-through from exchange rate changes to import price, implying that profits of the firm adjust to the full extent of the exchange rate changes. For the case of constant elasticity of demand, [$\lambda^e = -1$], pass-through is complete. A sufficient condition for this to occur is that demand elasticity and marginal cost are constant. If marginal costs are decreasing and elasticity of demand is constant pass-through is more than complete [$\lambda^e > -1$]. If marginal costs are increasing, then pass-through of exchange rate changes will be less than complete [$\lambda^e < -1$]. In short, when demand elasticity is constant, the form of the cost function determines the magnitude of the exchange rate elasticity.

Second, the elasticity of domestic import price with respect to foreign factor prices [λ^w=(dp/dw)(w/p)<1] should be less than fully passed-through. Because of the assumed separability of the cost function, the magnitudes of λ^e and λ^w are the same, except that the effects are of opposite signs. In general, we expect [$0 < \lambda^w < 1$], depending on the associated functional forms.

Third, the elasticity of domestic import price with respect to changes in the price of the domestic competing good [λ^q=(dP/dq)(q/p)] as well as the elasticity of import price with respect to income [λ^y=(dP/dy)(y/p)] can be negative or positive, depending on the specific form of the demand and cost function.

Fourth, the elasticity of domestic import price with respect to a change in tariff has the same effect on consumer price as a change in foreign factor prices. Feenstra empirically tested the symmetry hypothesis that pass-through of tariffs and exchange rates are equivalent. This hypothesis was accepted for Japanese cars, trucks and motor-cycles. The implication of accepting this hypothesis is that response of import prices to exchange rates can be used to predict changes in tariff rates.

Other researchers have applied the Feenstra's model to estimate exchange rate pass-through to domestic import prices in manufacturing industries (Mohammed, 1990) and in agriculture (Pompelli and Pick, 1990). Pompelli and Pick (1990) examined the extent to which exchange rate and tariff rate changes were passed-through to the United States import prices of unmanufactured Brazilian tobacco. The low estimated exchange rate pass-through from this study implies that Brazilian exporting firms may have used pricing strategies to maintain trade shares in the domestic market.

Pricing to Market Models

A sizeable literature has developed attributing incomplete exchange rate pass-through to the 'pricing to market' (PTM) phenomenon. Krugman (1987) asserted that PTM occurs if an exporter holds either his domestic currency export price constant or raises (lowers) it for an importer who has realized a domestic currency appreciation (depreciation). This has the effect of either allowing the importers domestic currency price to fall (by proportionally less than the exchange rate change) or maintaining a stable price. Hence, export markets are isolated from world price movements, and such an effect may show up in a pattern of price discrimination across export destinations.

Models of PTM assumes that firms are short-run profit maximizers with the ability to price discriminate by destination markets (e.g. Knetter, 1989; Ohno, 1989; Mann, 1986; Hooper and Mann, 1989; Krugman, 1987; Giovannini, 1988). In these representations, unless importers' elasticities of excess demand are constant, exporters will vary their markup of price over marginal costs in response to exchange rate movements, thus slowing the transmission of exchange rate shocks to import prices.

The key in PTM models is that less than complete exchange rate pass-through is interpreted as noncompetitive pricing behavior (i.e., price discrimination). PTM hypothesis is normally confirmed or refuted indirectly or directly. An example of the former is Jabara and Schwartz (1987). These researchers attributed the fact that during the 1970s when the United States dollar depreciated against the yen, they found complete pass-through. In contrast, in the early 1980s when the dollar appreciated, pass-through was lower (a higher degree of PTM).

Examples of direct tests of the PTM hypothesis applied to exchange rate pass-through and in the context of agriculture includes the empirical work of Pick and Park (1991) and Yumkella et al. (1994). Pick and Park (1991) applied Knetter's (1989) model of PTM to United States cotton, corn, soybeans, soybean meal, and wheat exports using quarterly data. They found evidence to support the PTM hypothesis only for wheat. This is consistent with other studies indicating that imperfect competition is important for wheat trade; but such behavior is due to government intervention rather than market power of firms. Yumkella et al. (1994) studied pricing behavior in the international rice market using PTM framework. They reported evidence of price discrimination across destination markets as well as through imperfect exchange rate pass-through.

Yang and Hwang (194) used a markup model and reported that Korean manufacturing firms export price response occurred quite rapidly (usually 2-3 months) to changes in sectoral exchange rates and raw material prices, while it took longer (4-5 months) for price changes to respond to changes in demand pressure. In contrast, they found that Korean domestic prices do not respond to changes in foreign prices and exchange rates. In general, they found that Korean exporters typically absorb 70 percent of a given change in exchange rates on foreign prices in their margin on export sales and pass-through the remaining 30 percent within 3 months. Their results further indicate that Korean manufacturing firms have followed a dual pricing strategy. For export pricing, they acted as price takers in the world markets, selling at the competitive world price. For pricing domestic sales, they act like discriminating oligopolists.

Hysteresis or Path Dependent Models

The hysteresis explanations of incomplete pass-through are based on irretrievable sunk costs associated with entry and exit decisions in international markets. The principal idea is that exchange rate fluctuations induced firms to adopt a "wait and see" attitude towards investments in expanding sales or distribution infrastructure and building up a reputation of reliability and consistency with customers. These models demonstrate that foreign firms are less likely to enter domestic markets following a temporary and or small exchange rate change if significant sunk costs are associated with entry. In addition, foreign firms will be reluctant to exit domestic markets after making these investments. Furthermore, they may continue to supply the domestic markets despite being unable to cover variable costs. This is because leaving the domestic market involves losing sunk cost as well as their reputation as a reliable supplier. Also, foreign firms consider the additional cost of re-entry, particularly if the exchange rate change reverts to its original level.

The hysteresis hypothesis maintains that intensity of competition in domestic markets will be unchanged, provided the exchange rate fluctuates within a given "hysteresis band" (a band within which the exchange rate exhibits a tendency to revert to its initial value), and this band will be wider the higher the costs associated with entry and exit (Baldwin, 1988b; Dixit, 1989). Lower rates of exchange rate pass-through occur because firms engage in strategic actions to stay in the market or deter entry. In addition, sunk entry costs on the supply-side tend to decrease pass-through, because exporters may elect to absorb the cost of devaluation through reduced margins in order to protect their market share (Baldwin, 1988b).

If the exchange rate moves outside the hysteresis band entry and exit follow and this may permanently alter market structure. That is, some of the new firms that have entered the domestic market will not leave easily, and some that have left may never re-enter. This may cause a structural break in pass-through relationship, because the new competitive structure of the market may not be consistent with the historical rate of pass-through (Baldwin, 1988a; Krugman and Baldwin, 1987).

Incomplete pass-through, on the supply side, is explained by (a) benefits associated with maintaining stable prices or the cost involved with frequently changing prices; and (b) the cost of changing supply. In the context of the United States fresh tomato market, assume for example, that the peso depreciates. Mexican exporters and their domestic importing firms may avoid passing-through the full price effects if expansion in sales requires expanded services such as specialized transportation, and distribution infrastructure. Expansion in infrastructure may be costly and a significant proportion of such costs would be sunk. Mexican exporters and their domestic importers would be inclined to incur these costs only if the depreciation (appreciation) would last long enough to recover their investments.

Even if the depreciation (appreciation) is viewed as relatively permanent, there would be little justification for Mexican firms to cut prices immediately if there was no capacity to meet the anticipated expansion in domestic demand. It is more likely that prices would fall gradually as additional infrastructure is put into place and, given time, pass-through should be complete. These supply side considerations suggest that incomplete short run pass-through can be explained by the perceived duration of exchange rate changes.

The "beachhead effect" (Baldwin, 1988b) results when a favorable exchange rate shock induces foreign suppliers to incur sunk costs in establishing distribution and service networks in the importing country. Some of these entrants will remain to compete with domestic producers even if the exchange rate returns to its initial level, due to asymmetry of entry and exit costs. The "bottleneck effect" (Baldwin, 1988a) assumes that firms are initially operating at full capacity, and that marginal costs are constant and jump discontinuously at full capacity. Therefore, exchange rate appreciation leads to capacity expansion and a price reduction. Subsequent reversal of the exchange rate does not alter capacity and, given the discontinuity of marginal costs, does not cause a price rise. In this case pass-through is zero.

Parallel to the supply side, is the case of exchange rate appreciation in the domestic market with sunk entry costs on the demand side. Demand side dynamics explain incomplete short run pass-through in terms of entry into markets to exploit arbitrage opportunity, and the response of existing (rivals) price setters in this market. Existing firms in the market are assumed to face sunk costs associated with expanding distribution and sales infrastructure in the short run. Even if existing firms have sufficient infrastructure to meet expanded demand, they might still fail to exploit arbitrage opportunities. This behavior is explained by lags in the adjustment of consumer demand to price differentials in the market. Slow adjustment of customers to price differences is explained by inadequate information about prices. Also, sticky consumer demand might be the result of transaction costs of switching suppliers, the cost of breaking established sales relationships, uncertainty about reliability of new suppliers and reluctance to ignore satisfactory relationships with traditional suppliers. These factors explain buyers reluctance to respond immediately to price differences.

The model of Froot and Klemperer (1989) is a good example of dynamic demand side effects in an oligopolistic market. Froot and Klemperer's work emphasizes pricing strategies of firms aimed at protecting market shares. It also explains how temporary versus permanent exchange rate changes affect strategic decisions. In brief, two periods are assumed, market share in the first period affects price response to an appreciation in the second period. A crucial aspect is that the results are independent of the type of competition assumed (Cournot or Bertrand), the functional form of the demand curve, the number of periods, and the reasons why market share is important. This paper demonstrated that price response to a temporary currency appreciation could lead firms to either increase or decrease prices. By contrast, an appreciation which is perceived as permanent leads foreign firms to price aggressively in the domestic market in order to increase market share. This occurs because future market shares depend on current market shares and any increase realized from exploiting an appreciation will be relatively permanent. Accordingly, exchange rate movements which enhance market share may cause a permanent outward shift in the demand for that firm's product as a result of habit formation among domestic consumers, resulting in asymmetric price responses to large exchange rate shocks.

Menon (1993a) employed a markup model similar in spirit to the well known model of Hooper and Mann (1989), to study exchange rate pass-through to the import price of Australian passenger motor vehicles. Quarterly data and error correction modeling (ECM) techniques were employed. Short and long run exchange rate pass-through estimates of 70 and 81 percent, respectively, were obtained. The discrepancy between short and long run elasticities were interpreted as "wait and see" attitudes adopted by traders to distinguish

between temporary and permanent exchange rate changes. Further, long run pass-through estimates of exchange rate and cost changes were found to be closel. Suggesting that exporters treat long term changes in exchange rate to be as permanent as cost changes. The long run coefficient on the domestic competing price was 26 percent, indicating divergence between competing and import prices. This finding means that domestic manufacturers are unable to keep price increases down to the same rate as for imported vehicles.

Approaches to Market Share Determination

Exporting and importing countries have pursued distortionary policies to increase the welfare of their producers and consumers. Market share should potentially capture the net impacts of these policies on trade flows. Attention to market shares has been central in the competition between Florida and Mexico. The objective of this section is to briefly review the techniques claiming to identify determinants of market share over time.

Durham and Lee (1987) reviewed three approaches to market share determination. These include stationary transition probabilities using markov models, direct market share equations, and multinomial logit (MNL) market share models. The specific details of these models are not elaborated here, instead, their main features are discussed. First, markov models assume constant transition probabilities across time. This is problematic because of the underlying presumption that the economic system remains stable.

Second, the market share approach specifies market shares as a function of key explanatory variables. In practice market share changes are expressed as a function of lagged share and one explanatory variable (relative price movements). This appears to be overly

simplistic (Durham and Lee, 1987). More significantly, however, is the absence of assurance that predicted shares lie in the logical range of zero and unity. In addition, if a set of equations is estimated, there are no guarantees that the sum of the predictions will be unity.

Third, the multinomial logit model (MNL) explains the behavior of all shares in one market and guarantees that the predictions lie in the logical range. Following Tyrell and Mount (1982) market shares can be expressed as an exponential function of the form

$$MS_{it} = (\exp^{f_{it}})\,(\sum_{j=1}^{n} \exp^{f_{jt}})^{-1} \qquad i, j=1,2,\ldots,n \tag{9}$$

where $f_{it} = a_{i0} + a_{i1}X_{1t} + \ldots + a_{in}X_{nt}$, that is, the f's denote linear functions of the explanatory variables. These explanatory variables may represent a variety of economic and other factors considered to influence market share behavior. One advantage of this framework is that it can be estimated by simple regression techniques if each f_i contains a stochastic residual (μ_i). To accomplish this the model is transformed by taking the nth share as the denominator, dividing all other n-1 shares by this term, and taking natural logarithms. This implies

$$\ln(MS_{it}/MS_{nt}) = f_{it} - f_{nt} + (\mu_{it} - \mu_{nt}) \tag{10}$$

Therefore for n suppliers, n-1 equations must be estimated. The attractiveness of this model is its flexibility. Different explanatory variables can be incorporated into each functional relationship. More importantly, we are assured that the predicted market shares sum to unity.

Smith (1988) used logit analysis to identify determinants of market share. This innovative approach is pertinent to the present study and as such deserves close scrutiny. First, the logarithmic version of the equation used by Smith is of the form

$$Ln(P^{us}) = \alpha_0 + \alpha_1 Ln(e) + \alpha_2 Ln(P^{for}) + \mu_t \tag{11}$$

where P^{us} is United States dollar price of some homogenous good, e is exchange rate in

dollars per unit of foreign currency, and P^{for} is foreign country price of the good. Given the likelihood of simultaneous determination of foreign and domestic prices, a two stage procedure was used to purge the foreign price term of simultaniety bias. If ordinary least squares or a two stage procedure is used, it is necessary to test the restriction: $H_0{:}\alpha_1=\alpha_2=1$. If the null hypothesis is not rejected, then there are two implications for the determination of domestic market share (Smith, 1988). First, the static analysis as depicted in (11) is not rejected by the data. Second, among the two prices and exchange rate, there are only two unique pieces of information. In modeling domestic market share for selected agricultural exports Smith specified the model:

$$S_i = f(ER_i, P_i^{us}, P_i^{for}) \tag{12}$$

where S_i is domestic market share of the ith commodity, and the other variables are as previously defined. A depreciation of the dollar against other currencies is expected to influence domestic market share positively. The sign on the price terms are indeterminate. A positive domestic price coefficient is not very useful for policy. A negative domestic price coefficient implies that the elasticity would have useful policy implications. The expected sign on the foreign price depends on whether LOP holds. If LOP cannot be rejected, domestic and foreign price are assumed to move in concert, diverging from each other only as the exchange rates move. If the LOP holds, including foreign price with domestic price and exchange rate is superfluous. If LOP does not hold, then higher foreign prices, other things remaining constant, would mean an increase in domestic export share. Smith applied equations (11) and a logistic form of (12) to annual data for United States to study the impact of exchange rate on export price and market share for wheat, corn, and rice prices.

Issues in Exchange Rate Pass-through Estimation

Substantial differences exist in the empirical literature regarding (a) levels of aggregation at which pass-through can be meaningfully evaluated; (b) econometric techniques used; (c) dynamic specification; (d) approaches to analyzing parameter stability; (e) choice of exchange rate measures; and (f) variables to include in exchange rate pass-through analysis.

The trend in pass-through literature has been to move from aggregate analysis and focus on industries (Menon, 1993a). Analyses at the industry or commodity level are justified because of the problems associated with aggregating heterogeneous goods and market structures. Melick (1994) asserted that pass-through assessment is best implemented at the industry or commodity level where known market structures can be incorporated into model specification (e.g. Feenstra, 1989; Knetter, 1993; Mohammed, 1990). Goodwin et al. (1990) support this position and suggest three justifications in an agricultural context. First, primary commodities are more likely to possess identical attributes regardless of origin or destination markets. Second, data problems of indexes and measurement errors due to aggregation are avoided. Third, the probability the exchange rate is endogenous is reduced when analyses are implemented using commodity prices.

Researchers have generally utilized ordinary least squares (OLS) to estimate pass-through equations with little or no attention paid to the time series properties of the data. Recent studies overcome this in terms of substantial attention paid to time-series properties of the data (e.g., Parsley, 1993; Menon, 1993a, 1995a; Dwyer et al., 1994; Gegowski, 1994; Goodwin and Schroeder, 1991; Athukorala and Menon, 1994; Ardeni, 1989; Baffes, 1991; Liu, 1993). These researchers recognized that macroeconomic time series data, including

income, wages and exchange rates, may be nonstationary (Nelson and Plosser, 1982; Liu, 1993; Parsley, 1993). Applying OLS to estimate equations with nonstationary variables introduces the possibility of spurious regression (Menon, 1995a). The data used in earlier estimations of pass-through are trended; therefore, the derived estimates may be biased. The high R^2 and low Durbin-Watson statistics reported in many early studies may be reflecting nonstationary residuals (Menon, 1995a).

Some authors are aware of problems caused by serial correlation and estimated their equations in first differences (e.g. Isard, 1977; Richardson, 1978) or using percentage changes in variables (Jabara and Schwartz, 1987). Whenever serial correlation is detected the routine practice is to resort to Cochrane-Orcutt or related transformations (e.g. Hooper and Mann, 1989; Wilamoski, 1994). The problem is that use of standard correction procedures in the presence of nonstationary variables lead to highly misleading results (Granger and Newbold, 1974; Menon, 1995a). Some researchers report only standard summary statistics, and ignore tests for possible misspecification of the regression and exogeneity of the regressors. Parsley (1993) argues that misspecification may be the reason why many studies reported breaks in the pass-through relationships.

Dynamic relationships are an important component in empirical specification of pass-through equations. It is easy to justify inclusion of lags and dynamic structures in empirical work based on considerations of incomplete information, costs of adjustment and delivery lags. However, specifying the form of such lags is much more difficult than justifying their inclusion. Polynomial lag structures are frequently used to estimate trade equations and pass-through elasticities (Mann; 1986; Hooper and Mann, 1989; Feenstra, 1989; Baharumshah and

Habibullah, 1993). Baharumshah and Habibullah (1993) employed polynomial lags to specify the adjustment of prices to exchange rate changes. The n-period distributed lag which they imposed on the exchange rate facilitated determination of the speed at which exchange rate adjustments are transmitted to commodity prices.

Parsley (1993) resolved the problem of dynamic specification by estimating each equation in error correction form (ECM). This methodology has been advocated as a means of avoiding illusory inference when the exact lag structures are unknown (e.g., Davidson et al., 1978; Hendry et al., 1984). One advantage of ECM is that it facilitates the distinction between short and long run effects (Davidson et al., 1978).

Stability of the econometric relationships is important for inferential and predictive purposes. Forecasts are meaningful only if the underlying relationship is stable. Likewise, confidence in estimated effects of changes in the underlying exogenous relationship is determined by the stability of the system under consideration. A complicating factor is that a change in trade relationship, should it occur, may either happen suddenly or gradually through time. For example, an oil shock may exert a sudden change on supply or demand relationship. Alternatively, changes in policy or the distribution of income can alter the trade elasticities. The problem of whether the pass-through relationship has changed involves two related issues. First, the coefficients may have changed. Second, only the dynamics of pass-through have changed, while the long run effects remain unchanged (Kim, 1990).

Most studies applied Chow tests for detecting structural breaks in the pass-through relationship (e.g. Hooper and Mann, 1989; Wilamoski, 1994; Parsley, 1993; Baharumshah and Habibullah, 1993). The Chow test requires the assumption that a possible break is known

a priori, which may not be the case (Menon, 1995a). Parsley (1993) tested pass-through stability pre and post, a specified date. These dates were chosen to ensure ample degrees of freedom in both sub-samples and to approximate roughly the period in which there was a suspected change in pass-through. The two pass-through coefficients from each regression were then tested for equality using the Chow test. The results indicated very little evidence of instability either at the industry or aggregate level.

Some researchers, (e.g. Rockerbie, 1992; Menon, 1993b; Kim, 1990) addressed the issue of structural breaks using CUSUM and CUSUMSQ tests for each of the equations based on the framework of Brown et al. (1975). This test is appropriate when it is not known when the structural breaks in the price equation occurred (Rockerbie, 1992).

In general, the literature on exchange rate pass-through takes a partial equilibrium approach to analyzing the effects of exogenous exchange rate changes within a particular industry. Although it is appropriate to take the exchange rate as exogenous to the agricultural sector, it is still important to discriminate between real changes and purely inflationary ones. Much of the literature does not clearly distinguish between nominal and real exchange rates. Some researchers treat pass-through in nominal terms (e.g., Mann, 1986; Hooper and Mann, 1989; Chambers and Just, 1981; Feenstra, 1989), others use real values (Alston et al.,1992).

The pass-through literature highlights the importance of the choice, construction, and aggregation of price and cost data. The selection of proxy variables depends on whether the analysis is at the aggregate or commodity level. For example, previous studies have relied on unit value indexes as the measure of import price at the aggregate. These indexes suffer from well-known deficiencies (Lipsey et al., 1991). In contrast, unit values for commodities yield

an accurate price (Menon, 1995a, 1995b). For real foreign cost, Parsley (1993) used fuel cost in exporter currency deflated by a consumer price index in both aggregate and disaggregate analyses. In contrast, Hooper and Mann (1989) used a weighted average of fuel costs and unit labor costs in their aggregate model.

Bhagwhati (1988) has referred to the failure to recognize the important role played by non-tariff barriers (NTBs) as the missing link in solving the pass-through puzzle. The presence of quantitative restrictions (QRs) implies that a peso depreciation, will generally cut into the import premium first, thus absorbing much of its impact before it is reflected in prices. It is only when the depreciation is large enough to push prices to the point where quantity restrictions are no longer binding that some pass-through will be observed. Menon (1995b) tested the Bhagwati hypothesis by investigating the effects of NTBs on the pass-through relationship. He found that most of the variation in pass-through was explained by the presence of non-tariff barriers.

Summary of Review

In summary, there is no single, coherent theory of exchange rate pass-through. Classical trade theory (e.g., LOP) assumes perfectly competitive markets, homogeneous goods, many buyers and sellers, no market power and absence of distortions. However, many agricultural commodities, fresh tomatoes not excluded, may be traded in markets which are not perfectly competitive. Under perfect competition and constant marginal cost, exchange rate adjustments are passed-through completely to domestic import price. Under oligopoly, domestic import prices will fall proportionately less than the exchange rate adjustment.

Consequently, the adverse effect of exchange rate depreciation on the domestic industry will be smaller under oligopoly. This result suggests that using the competitive market assumption to estimate exchange rate pass-through provides upper-bound estimates if the true market structure is oligopoly. Therefore, an oligopoly framework which encompasses various market structures is a desirable feature. To evaluate the effects of exchange rate on domestic import prices, it is necessary to go beyond the LOP as a model of import price determination. We need to incorporate some facet of imperfect competition which recognizes that firms interact strategically. Inclusion of these features greatly expands the role of the firm as a strategic profit maximizing agent. In this regard, a major strength of Feenstra's (1989) model is that it is amenable to empirical estimation and testing. This flexibility is possible because of its relative simplicity, especially compared to richer oligopoly models of conjectural variations.

Models that develop a PTM explanation of the pass-through phenomenon, besides imperfect competition, involve dynamic supply side and demand side effects with some story about maintaining market share in the face of exchange rate fluctuations and expectations about the behavior of the exchange rate. Abbott et al. (1993) expressed concerns that it may be risky to rely exclusively on the exchange rate to identify patterns of discriminatory pricing behavior. The main reason for this risk is because exchange rates may be correlated with other variables, such as macroeconomic performance, which are important determinants of agricultural trade. Another issue is that a direct test of the PTM hypothesis requires more than one export destination, or that firms sell in their domestic market as well as overseas. This consideration renders the direct test of the PTM framework unsuitable for analyzing the Mexican fresh tomato export which is destined for the United States market.

CHAPTER 4

MODEL SPECIFICATION AND EMPIRICAL ESTIMATION

Under competitive market conditions exchange rate changes are assumed to result in instantaneous and proportionate price adjustments (Cowling and Sugden, 1989). An influential body of literature has emerged arguing that price-taking behavior has limited application to actual pricing decisions of firms in many industries (Dunn, 1970). This literature contends that uncertainty regarding competitors' reaction to price changes, the direct cost of making frequent price changes, the firms' desire to appear respectable to customers, inertia, asymmetric information flows, risk, market distortions of various kinds, and customer opposition to frequent price movements are distinct features of actual pricing decisions. According to this view some agricultural markets may not be instantaneously integrated; however, integration may occur after prices have had time to adjust.

Economists are increasingly incorporating these views in refining theoretical and empirical models of agricultural trade and policy. In this context, oligopoly theory has played a central role. Examples include Just and Chern (1980) for tomato harvesting, Lopez (1984) for Canadian food processing, Deodhar and Sheldon (1995) for banana marketing and Paarlberg and Abbott (1986) for wheat. These analysts were interested in testing hypotheses regarding alternative market structures. This approach is useful because trade and other

macroeconomic policies have different impacts under different market structures. Models which accommodate a range of market structures provide a commendable analytical strategy.

Compelling justifications can be advanced for not modeling the rivalry between the United States and Mexican suppliers in the domestic market for fresh tomatoes as perfectly competitive. First, perfect competition presumes that firms are independent. That is, the actions of domestic firms have no effect on those of their foreign competitors. In contrast, models of oligopoly presume that firms believe they are interdependent and must take into consideration the behavior of rival firms in the market. Real-world oligopolies are cognizant that their actions may trigger strategic counteractions by rivals. Mathematical representations of oligopolistic behavior make specific assumptions about the conjectures firms make regarding how their rivals will respond to changes in either prices or quantities.

Second, Jordan and VanSickle (1995a) modeled competition between Florida and Mexico in the United States market for fresh tomatoes as oligopolistic. Their justification was that both suppliers account for more than 95 percent of the market, and as such, prices received by each are expected to influence those of the other. Under these circumstances market behavior may cover the spectrum from intense rivalry to collusion. The conclusions of their empirical analysis which are pertinent to this discussion include (a) spatial price adjustments are not instantaneously transmitted, but eventually each supplier responds to the price and quantity variations of the other; (b) Florida appears to lead the price formation process. In other words, Florida's price is much more dependent on its own past values than on past Mexican prices, but Mexican prices are eventually taken into consideration; and (c) Florida prices are a significant factor determining Mexican price in the short run.

Third, Jordan (1995) applied a duopoly framework and Cournot conjectural variations to empirically investigate the United States market for fresh tomatoes in which Florida and Mexico are major players. His results show that the United States market is noncompetitive, and Florida and Mexico exercised market power during the seasons covered by the data.

Fourth, Mexican and United States governments have both actively supported their respective fresh tomato industries through institutions and trade policy. In the case of Mexico, the VER implemented through the National Horticultural Producers Union (UNPH) captures tariff equivalent revenues for their producers. Bredahl et al. (1987) speculated that Mexican producers could be exerting market power through the VER, from which Mexican and United States producers gain at the expense of domestic consumers. Furthermore, PAQs implemented by CAADES may enhance market price (Hammig and Mittlehammer, 1982).

In the case of the United States, the Federal Marketing Order (FMO) may enhance market power through volume control management (Taylor and Kilmer, 1988). The FMO provides grade, size and maturity specifications for domestically produced and imported tomatoes. This action affects supplies and ultimately prices. In addition, differential tariffs are imposed by the United States on Mexican fresh tomato imports. This tariff is high when domestic production is high and low when domestic production is low. By limiting Mexican competition the tariff assists in internalizing rents and enables United States (home) firms to obtain a noncompetitive equilibrium in the domestic market (Bredahl et al., 1987). These observations insinuate that governments in both countries coordinate production and or marketing to benefit their producers. This behavior is consistent with what Kolstad and Burris (1986) refer to as imperfect competition among nations. Competition between Mexico

and the United States is made more complicated because governments in both countries are simultaneously conducting trade policies which affect the industry. This introduces the issue of strategic interaction among governments, because oligopolistic interactions among private producers significantly influence the policy formation process (Dixit, 1984).

Fifth and possibly most important, is the incidence of collusion among Mexican export firms which is encouraged or arranged by government. In such circumstances, countries are the logical units of analysis, and trade is naturally oligopolistic (Dixit, 1984). In the fresh tomato market, governments support growers' associations which coordinate producer actions; hence, there may be scope for oligopoly (Kolstad and Burris, 1986). For instance, there are 12 grower associations organized into CAADES which serves to coordinate the actions of producers; therefore, producers may behave as an oligopoly or oligopsony (Kolstad and Burris, 1986). Two recent voluntary actions highlight the power of this organization. CAADES has concertedly raised quality standards so that at least 90 percent of their tomato shipments to the United States satisfy the domestic No.1 grade. In addition, they reportedly halted exports to the United States for two days in 1996 for the purpose of increasing domestic prices (Plunkett, 1996).

Sixth, production is geographically concentrated in the United States and Mexico; therefore, even if we concede that production occurs in atomistic units, marketing may still be oligopolistic. This is because marketing and trade are carried out by even fewer trading firms (Bredahl et al., 1983; VanSickle et al., 1994). About five distributors handle 75 percent of Mexican tomato imports (USITC, 1996; VanSickle et al., 1994). Thus, the number of firms may be small enough for market power and strategic interactions to be important.

Finally, agroclimatic factors restrict entry of other domestic suppliers into the market, while transport costs and tariffs prevent other countries from supplying significant quantities. These empirical and stylized facts influenced the choice of the analytical model discussed in the next section. The essence of the oligopoly framework adopted for the current study is that foreign and domestic producers recognize the interdependence of their pricing decisions in the home market for fresh tomatoes. An immediate implication is that costs may change, but prices remain unchanged because prices in an oligopoly tend to be inflexible downwards (Cowling and Sugden, 1989; Dunn, 1970).

In modeling the domestic market for fresh tomatoes, care is exercised not to define an overly restrictive market structure. On the surface, there are far too many individual producers to apply a conventional imperfect competition model. Hence, the strategy adopted is considered ideal because it facilitates a wide range of market structure outcomes which ultimately will be determined by data.

Conceptual Framework

Three assumptions are germane to the theoretical model which follows. First, all United States production is assumed to be consumed at home. Similarly, the total Mexican (foreign) supply is assumed to be exported to the United States. This permits sales in Mexico and United States exports to be ignored. Second, domestic and Mexican tomatoes are treated as perfect substitutes. This means both industries face the same elasticity of demand, therefore, supplies from both sources can be summed to obtain total quantity. It is recognized that quality differences exist (e.g., extended shelf life varieties and vine ripe versus mature

green), but these are not significant enough to invalidate this assumption. Furthermore, there are no disaggregated data series available according to types. Third, Mexico and the United States are assumed to be large countries. However, the fresh tomato industries are small relative to their respective total economies; therefore, a partial equilibrium framework is appropriate. Furthermore, because this analysis is conducted at the commodity level there is a reduced probability that exchange rates are determined endogenously (Goodwin, 1992).

Tomato Import Price Function

The Bertrand model of imperfect competition which constitutes the theoretical basis for this study was adopted from Feenstra (1989) and Pompelli and Pick (1990). The United States demand faced by Mexican exporters can be expressed as

$$Q = Q(P^F, P^D, P^S, Y) \tag{13}$$

where the quantity of tomatoes demanded by domestic importers (Q) is a function of the import price (P^F) in dollars, price of domestic produced tomatoes (P^D), price of substitute tomatoes (P^S) and domestic income (Y).

Production technology of differing vintage and efficiency, variations in wage rates, transportation costs and raw material prices all make it unlikely that rivals will have identical cost structures. Mexican producers are assumed to face the cost function

$$C = C(Q, W^*) \tag{14}$$

where W^* denotes a vector of Mexican factor prices. Assuming this cost function is

homogeneous of degree one in factor prices, it can be rewritten as

$$C(Q,W^*) = \theta(Q).W^* \tag{15}$$

where $\theta''(Q)>0$ (or<0) indicates rising (falling) marginal costs. Each firm in the industry maximizes profits with respect to the choice variable P^F as follows

$$Max\ \Pi = [ER(P^F - TFF)Q(P^F,P^D,P^S,Y) - \theta(Q)W^*] \tag{16}$$

In this formulation ER denotes the peso-dollar exchange rate, and TFF is the unit rate of tariff. This profit maximization specification reflects the fact that Mexican suppliers receive payments in dollars. Accordingly, when the dollar appreciates relative to the peso, Mexican suppliers obtain a windfall gain in revenue when they convert domestic currency to pesos. One implication of this is that Mexican exporters may choose to increase their share of the domestic market by lowering the dollar price of their tomatoes, leaving their unit revenues in pesos unchanged. This strategy is feasible if costs of production rise proportionately less than changes in the exchange rate. Equation (16) can be stated alternately as

$$Max\Pi = P^F Q(P^F,P^D,P^S,Y) - (TFF)Q(P^F,P^D,P^S,Y) - \theta(Q)(\frac{w^*}{ER}) \tag{17}$$

The first order condition from (17) is

$$\begin{aligned} \frac{\partial \Pi}{\partial P^F} = Q(P^F,P^D,P^S,Y) \ + \ P^F(\frac{\partial Q}{\partial P^F}) - TFF(\frac{\partial Q}{\partial P^F}) \\ -(\frac{\partial \theta}{\partial Q})(\frac{\partial Q}{\partial P^F})(\frac{W^*}{ER}) = 0 \end{aligned} \tag{18}$$

Rewriting equation (18) gives

$$\begin{aligned} Q(P^F,P^D,P^S,Y) + (P^F)Q'(P^F) \ = \ \theta'(Q)Q'(P^F)(\frac{W^*}{ER}) \\ + \ (TFF)Q'(P^F) \end{aligned} \tag{19}$$

Factoring out $(P^F)Q'(P^F)$ from RHS and $Q'(P^F)$ from LHS of 19 gives

$$Q'(P^F)(P^F)[\frac{Q(P^F,P^D,P^S,Y)}{(P^F)Q'(P^F)}+1]=Q'(P^F)[\theta'(Q)(\frac{W^*}{ER})+TFF] \tag{20}$$

Defining the negative of the elasticity of demand and marginal revenue, respectively, as η=-$Q'(P^F)(P^F/Q)$ and $R(P^F, P^D, P^S, Y)$, equation (20) can be expressed in elasticity form as

$$(P^F)(1-\frac{1}{\eta}) = R(P^F,P^D,P^S,Y) = \theta'(Q)(\frac{w^*}{ER})+TFF \tag{21}$$

Equation (21) is the familiar condition that marginal revenue equals marginal cost plus the unit tariff. The second order condition for a local maximum requires that the rate of increase in the Mexican firms' marginal revenue be less than the rate of increase in its marginal costs [i.e., $(\theta''(Q_P)(W^*/ER)-R_P^F)<0$]. Assuming this condition is satisfied, equation (21) can be inverted to obtain the pricing equation. Solving for Mexican producer price [$Pm=P^F$-TFF], the general functional form for the pricing equation can be represented as

$$Pm = g[(\frac{w^*}{ER}),P^D,P^S,Y,TFF] \tag{22}$$

Equation (22) states that the Mexican producer price that maximizes profits is a function of Mexican factor prices, the price of domestic tomatoes, the price of substitute tomatoes, domestic income, and the unit tariff rate. This equation should be homogeneous of degree one, that is $\Sigma\alpha_i=1$. If (22) has the appropriate mathematical structure the pricing equation can be written in log-linear form as

$$pm_t=\alpha_0+\alpha_1 p_t^S+\alpha_2 p_t^D+\alpha_3 w_t^*+\alpha_4 er_t+\alpha_5 tff_t+\alpha_6 y_t+\mu_t \tag{23}$$

where pm_t is dollar price of imported tomatoes, α_0 is a constant term, and μ_t is an error term. Other variables were defined previously and lower case letters indicate natural logarithms.

Details of the comparative static results are derived in Feenstra (1989) and are not reproduced here. The substitute price coefficient (α_1) is expected to be positive. The domestic tomato price coefficient (α_2) measures the degree of substitution between imports and domestic production. It should be positive since imports are substitutes for domestic production, but not greater than one. The standard case is for it to be positive but less than fully passed-through. However, the pass-through effect could be negative in the case where exporters' marginal costs decline as imports rise. The factor cost coefficient (α_3) should be positive. Exchange rate pass-through, the coefficient on the exchange rate variable (α_4), should be negative because import prices will be reduced when the peso depreciates. It indicates the elasticity of import price to changes in the exchange rate. The tariff pass-through coefficient (α_5) is expected to be positive and follows the same logic as the exchange rate coefficient. However, it is not restricted to be equal to the exchange rate effect (Pompelli and Pick, 1991). The elasticity of import prices to changes in income (α_6) should be positive, since an increase in domestic income leads to a higher demand for imports, thus increasing dollar import price. Theoretically, α_6 could be positive or negative (Deardorff and Stern, 1978). Finally, for estimation purposes, the error term (μ_t) is assumed to be log-normally distributed with an expected value of zero (Pompelli and Pick, 1990). Normally, the import price equation could be tested for homogeneity of degree one (i.e., $\sum\alpha_i$=1). Feenstra (1989) noted that a tariff pass-through coefficient that is less than unity indicates that the importing country achieves terms of trade gains. He also estimated two specifications, one with the term [w^*/er] and the other with w^* and er separately. The w^* and er specification allows for testing their equality.

Determinants of Mexican Market Share

The literature generally has not clearly distinguished the exchange rate effects on agricultural prices from the effects on trade volume (Alston et al., 1992). Therefore, the second aspect of our empirical investigation is to explain the impact of exchange rate changes on Mexican market share. Our approach is a modified version of Smith (1988). Mexican share of apparent domestic consumption in time t (S_t) is an implicit function of domestic price (P^D), foreign price in domestic currency (P^F), Mexican labor cost in pesos (W^*), exchange rate (ER), tariff rates (TFF), and domestic income (Y). The influence of other variables such as variations in production and or consumption are expected to show up as random fluctuations in the error term. The general form of the Mexican share equation is

$$S_t = f(P_t^D, P_t^F, W_t^*, ER_t, TFF_t, Y_t) \tag{24}$$

Mexican market share should be an increasing function of a depreciating peso-dollar exchange rate, falling tariff rates, rising income, and a decreasing function of rising input costs. The signs on the price terms are indeterminate. A negative sign on the foreign price coefficient (P^F) indicates that Mexican market share declines with increases in own price. This makes practical sense, however, a positive sign indicates that Mexican market share increases when own price rise. Such a result would be uninteresting for policy. The expected sign on the domestic price (P^D) depends on whether LOP holds. If LOP is supported, Mexican and Florida prices should move together diverting from each other only as exchange rates change. If LOP holds (i.e., P^F=P^D) including Mexican price, domestic price and exchange rate would be superfluous (Smith, 1988). If LOP is rejected (i.e., $P^F \neq P^D$) higher domestic prices, other things remaining constant, imply an increase in Mexican market share.

Specification and Description of Empirical Models

This section covers the specification of the empirical models used to estimate (a) the pass-through of changes in exchange rate and other factors to the import price of Mexican fresh tomatoes in the United States market; and (b) determinants of Mexican market share.

Error Correction Model of Tomato Import Price

An error correction model (ECM) was chosen for estimating the tomato import price regression. Equation (23) is a static long run equilibrium specification. Short run adjustment to this long run equilibrium was described by an autoregressive distributed lag (ADL) model of the form

$$\Delta pm_t = \beta_0 + \sum_{i=1}^{k} \beta_{1i} \Delta pm_{t-i} + \sum_{i=0}^{j} [\beta_{2i} \Delta p^S_{t-i} + \beta_{3i} \Delta p^D_{t-i} + \beta_{4i} \Delta w^*_{t-i} + \beta_{5i} \Delta er_{t-i} + \beta_{6i} \Delta\ tff_{t-i} + \beta_{7i} \Delta y_{t-i}] + \lambda\ \mu_{t-1} + e_t \tag{25}$$

where all variables are as defined above, e_t is a short run random disturbance term, Δ is the first difference operator, k is the maximum lag length on pm and j's are the maximum lag length on each of the other explanatory variables. These lags ensure that the residuals are white noise. The β_{ij} are coefficients to be estimated, the parameter λ is the error correction coefficient. Providing the random disturbance term (μ_t) in equation (23) is stationary, both equations (23) and (25) may be estimated using (a) the two-step procedure (Engle and Granger, 1987) or (b) the unrestricted error correction procedure (Mehra, 1991; Carruth and Schnabel, 1990).

The Two-step Estimation Procedure

The first step in the Engel-Granger procedure involves OLS estimation of equation (23) as the long run equilibrium model and recovering the residuals. In the second step, the short run tomato import price equation (25) is estimated with μ_{t-1} replaced by the residuals obtained from step one. The error correction coefficient (λ) has to be negative to ensure that the short run import price function will converge to its long run equilibrium. A negative and statistically significant λ implies the existence of some disequilibrium in the long run relationship. This approach has been the standard practice in the cointegration literature.

Banjarjee et al. (1986) argue that including the error correction term (μ_{t-1}) in equation (25) imposes restrictions on the estimated coefficients. He finds serious problems of bias in the estimated coefficients and suggests estimating an unrestricted version of equation (25) by including lagged level variables from the cointegrating equation as regressors. Mehra (1991) conveys a similar view, contending that the error term in the cointegrating equation (23) could be serially correlated or heteroscedastic, rendering standard test statistics invalid. He recommended that a combined cointegration and error correction model be estimated instead of estimating the long run equation (23) and the short run error correction equation (25) in two different stages. According to Mehra (1991) the residuals from the combined estimation are likely to be well behaved, validating the use of standard test statistics in conducting inference.

The Unrestricted Error Correction Model

The unrestricted dynamic error correction model is derived from substituting for the error correction term in (25) as shown below. Using equation (23), define μ_t as

$$\mu_t = pm_t - (\alpha_o + \alpha_1 p_t^S + \alpha_2 p_t^D + \alpha_3 w_t^* + \alpha_4 er_t + \alpha_5 tff_t + \alpha_6 y_t) \qquad (26)$$

Lagging μ_t in (26) by one period and substituting the resulting expression into equation (25) we obtain

$$\begin{aligned} \Delta pm_t = \gamma_0 + \sum_{i=0}^{k} [\beta_{1i} \Delta pm_{t-i} + \beta_{2i} \Delta p_{t-i}^S + \beta_{3i} \Delta p_{t-i}^D + \beta_{4i} \Delta w_{t-i}^* \\ + \beta_{5i} \Delta er_{t-i} + \beta_{6i} \Delta\ tff_{t-i} + \beta_{7i} \Delta y_{t-i}] + \gamma_1 pm_{t-1} \\ + \gamma_2 p_{t-1}^S + \gamma_3 p_{t-1}^D + \gamma_4 w_{t-1}^* + \gamma_5 er_{t-1} + \gamma_6 tff_{t-1} \\ + \gamma_7 y_{t-1} + \xi_t \end{aligned} \qquad (27)$$

where $\gamma_0 = (\beta_0 - \alpha_0 \lambda)$; $\gamma_1 = \lambda$; $\gamma_2 = -\lambda\ \alpha_1$; $\gamma_3 = -\lambda\ \alpha_2$; $\gamma_3 = -\lambda\ \alpha_2$; $\gamma_4 = -\lambda\ \alpha_3$; $\gamma_5 = -\lambda\ \alpha_4$; $\gamma_6 = -\lambda\ \alpha_5$; $\gamma_7 = -\lambda\ \alpha_6$ As shown, the coefficients of the cointegration equation can be recovered by dividing the estimated coefficients on the lagged independent variables (variables measured in levels) by the coefficient on the lagged dependent variable [pm_{t-1}]. Since the short run (variables measured in first difference) and long run (variables measured in levels) should provide the same estimate of long run elasticity, Mehra imposed the restriction that the estimates of the long run elasticity derived from the sum of the coefficients from the short run part of the model are equal to the estimate of the elasticity from the long run part of the model. In the present context, no such constraint was imposed. Therefore our estimation of the unrestricted ECM is similar to the model estimated by Carruth and Schnabel (1990).

Mexican Market Share Estimation

The dependent variable in the implicit market share equation (24) is a proportion, therefore its distribution is not strictly normal. The cumulative logistic probability function is suitable since the boundary values are zero and unity. It has the advantage of transforming the dependent share variable from one contained within the interval (0,1) to an unbounded interval (-∞,+∞). For the present application, the logistic function is

$$S_t = \frac{1}{1 + \exp^{(-\beta \ln Z_t - \delta_7 T - \delta_8 F - \delta_9 D)}} \tag{28}$$

where $\beta \ln Z_t = \delta_0 + \delta_1 \ln(P_t^D) + \delta_2 \ln(P_t^F) + \delta_3 \ln(W_t) + \delta_4 \ln(ER_t) + \delta_5 \ln(TFF) + \delta_6 \ln(Y_t) + v_t$, v_t is a random disturbance term; T, F, and D are dummy variables representing technical change, Florida freeze and seasonal differences, respectively; and exp is the natural logarithm exponential operator. Equation (28) can be written as (29) or (30).

$$\exp^{(-\beta \ln Z_t - \delta_7 T - \delta_8 F - \delta_9 D)} = \frac{1 - S_t}{S_t} \tag{29}$$

$$\exp^{(\beta \ln Z_t + \delta_7 T + \delta_8 F + \delta_9 D)} = \frac{S_t}{1 - S_t} \tag{30}$$

Taking logs of (30) and substituting for Z_t gives the equation to be estimated as

$$\begin{aligned} \ln\left(\frac{S_t}{1 - S_t}\right) &= \delta_0 + \delta_1 p^D + \delta_2 p_t^F + \delta_3 w_t^* + \delta_4 er_t \\ &\quad + \delta_5 tff_t + \delta_6 y_t + \delta_7 T + \delta_8 F + \delta_9 D + v_t \end{aligned} \tag{31}$$

where all the lowercase letters denote natural logarithms.

Interpretations of the estimated coefficients in (31) are different from those in standard OLS estimation. The marginal effect of the j-th explanatory variable on the dependent variable or the percentage change of the Mexican market share of apparent United States consumption with respect to percentage changes in the indicated variable is given by (32),

where (1-S) is calculated at the mean for January, 1978 to June, 1996 period.

$$\frac{\partial \ln S}{\partial \ln(\textit{the j-th explanatory variable})} = \hat{\delta}_j(1 - S) \tag{32}$$

Econometric Methodology and Data

The first version of the tomato import price estimation or the Engle and Granger (1987) two-step error correction model (ECM) is represented by equations (23) and (25). The second version, or the unrestricted dynamic error correction model (UDECM), is represented by equation (27). The Mexican market share model is represented by equation (31). All equations were estimated by ordinary least squares (OLS). The TSP econometric package (Hall et al.,1995) was used to generate the parameter estimates.

The general to specific modeling strategy (Hendry et al., 1984) was employed for estimating the dynamic equations (25) and (27). This dynamic modeling approach begins with estimation of both equations initially with 12 lags, since monthly data were used. Insignificant regressors were progressively eliminated using the F-test. Finally, a simpler model with all insignificant coefficients deleted was re-estimated.

The number of lags on each of the (first differenced) variables included in either (25) or (27) was determined by a combination of Akaike's (1974) information criterion (AIC) and the Ljung and Box (1979) Q-statistic [Q(m)]. Unlike the Durbin-Watson test, the Q(m) tests the null of no autocorrelation versus the alternative of any kind of autocorrelation up to some presumed maximum order (Kmenta, 1986). The general procedure is to first determine the minimum number of lags required to remove autocorrelation. This is indicated by an insignificant Q(m) statistic. Next we observe if inclusion of additional lags results in a

substantial decrease in the AIC. Since seasonally unadjusted monthly data are used, the length of the lag structure (k) was set at 12 periods. This chosen lag structure itself is usually expected to allow for seasonality in the data series. However, if the dependent variable tends to exhibit strong and persistent seasonal behavior, seasonal effects may still be present. On these grounds, monthly dummies could be added to the model.

In proceeding from a general to a more specific model it is important to test the model in a number of ways. It is necessary to test for a homoscedastic serial uncorrelated error process at an early stage since all further testing is (usually) dependent on white noise errors as the maintained hypothesis. We must test the restrictions directly and also check that the assumptions are not violated in the restricted model. Furthermore, coefficients may vary across time, a typical effect of coefficient variation is to make the regression disturbance heteroscedastic and possibly autocorrelated. Therefore, testing for homoscedasticity and autocorrelation is essential.

Lags on the dependent variable were introduced as regressors to reflect reluctance of firms to adjust prices quickly. In this context they are referred to as coefficients of adjustment (Feenstra, 1989; Alston et al., 1992). Many researchers working with lag models attempt to control the erratic behavior of the coefficient estimates by introducing polynomial distributed lags (PDL) with or without constraints. In the present application these were avoided.

Time Series Properties of the Data

Recent advances in econometric theory have activated attention to the properties of time series data utilized in regression analysis of exchange rate pass-through. Attention to

this issue is especially motivated by empirical research confirming that many economic time series are characterized by nonstationarity. In a statistical sense, this implies that the mean, variance, and covariances of nonstationary series are time dependent. The main implication is that with nonstationary variables, it is inappropriate to apply standard OLS for estimating relationships. Doing so generally gives rise to problems of spurious regression from which reasonable inferences cannot be drawn (Granger and Newbold, 1974; Phillips, 1988). Spurious regression usually is indicated by excellent fit between unrelated variables as indicated by a high R^2 but a very low Durbin Watson (DW) statistic. This is often the case when levels of variables are used in the regression. According to Granger and Newbold (1974), a high R^2 may reflect correlated trends rather than a true underlying economic relationship, while a low DW statistic may indicate a high level of autocorrelated residuals.

In the current study, cointegration techniques were utilized for verifying the existence of long run equilibrium relationships among economic variables postulated by our theory, and to minimize the risk of spurious regression (Granger, 1986; Hendry, 1986; Engle and Granger, 1987).

Testing the Order of Integration

Stationarity or nonstationarity of variables included in the estimating equations were investigated. The Dickey and Fuller (1979) (henceforth DF) and the augmented Dickey and Fuller (1979, 1981) (henceforth ADF) tests were used to explore this issue.

The DF test for each variable, measured in levels, involved regressing changes in the level of the series against its level lagged one period. The general form of the regression was

$$\Delta X_t = \alpha + \beta X_{t-1} \tag{33}$$

If the coefficient (β) is negative and its absolute value exceeds the critical value provided by Dickey and Fuller (1981), the null hypothesis of nonstationarity is rejected and the series is considered I(0). If, however, the absolute value does not exceed the critical value, the following equation will be estimated

$$\Delta\Delta X_t = \alpha + \beta X_{t-1} \tag{34}$$

where $\Delta\Delta$ refers to the second order differencing of the variable. If the null hypothesis of nonstationarity is rejected at this stage, the series is considered to be I(1) and the change in the series is considered to be I(0). Differencing once should produce stationarity for most economic time series.

With the ADF test (Engle and Granger, 1987), lagged first differences are added to the estimation of equation (33) and lagged second differences are added to equation (34). The number of lagged values of the first differences of the dependent variable introduced to ensure that e_t is white noise was determined by a combination of Akaike's (1974) information criterion and Ljung and Box (1979) Q-statistics. Straightforward modifications to equations (33) and (34) can be made by deleting the intercept (drift) term or adding a trend term. Such determinations were made using the testing sequence suggested by Dolgado et al.(1990).

Testing for Cointegration

Cointegration analysis essentially tests for existence or nonexistence of a long run equilibrium relationship among variables postulated by theory. Testing for cointegration is, therefore, a prerequisite to achieving a dynamic specification which is consistent with the data set (Parsley, 1993).

The primary idea underlying cointegration analysis is that two or more nonstationary variables which are I(1) can be combined to form a stationary variable (Z_t) even though each individual variable is itself nonstationary. A general exposition of cointegration may be given by the simple case of two time series, x_t and y_t, which are individually nonstationary or I(1). If there exists a non-zero constant (β) such that $Z_t=x_t-\beta' y_t$ is a stationary or I(0) process, then x_t and y_t are said to be cointegrated with a cointegrating parameter β'. This implies that the set of I(1) variables (X_t, y_t) do not diverge over time, since Z_t has no trend in mean.

The Engle and Granger (1987) cointegration test procedure was implemented by ordinary least squares (OLS) estimation of equations (23) and (31). The residual series $\{\hat{e}_t\}$ from each cointegrating regression with alternate variables as the dependent variable was examined to determine whether they are I(1). If the residuals in (23) and (31) are stationary, the cointegrating vector among these variables is said to exist, implying the existence of a stable long run relationship among these variables.

Two desirable features of cointegration analysis deserve mention. First, cointegration analysis facilitates testing for the existence of long run relationships among variables postulated by our economic theory (e.g., equations 23 and 31). Second, cointegration provides support for using error correction modeling (ECM). The link between cointegration

and ECM follows from the Granger representation theorem. This theorem states that if a set of I(1) variables is cointegrated, there always exists an ECM representation among the variables (Granger, 1986; Engle and Granger, 1987). It also suggests that one can estimate an ECM that takes into consideration the short run dynamics of all variables included in the cointegrating regression.

Stability of Regression Relationships

Regression analysis of time series data is generally based on the assumption that the regression parameters are constant over time. In exchange rate pass-through studies it is desirable to investigate this assumption. The technique of recursive residuals is employed for such analysis. However, the focus is the CUSUM and CUSUMSQ tests (Brown et al., 1975).

The CUSUM test is simply the sum of the recursive residuals normalized by the standard error of the residuals. If the residuals are random we would expect the CUSUM statistic to be close to zero. Any systematic departure from zero suggests misspecification. The CUSUMSQ statistic is the sum of the squared recursive residuals normalized by the residual sum of squared errors for the full period, so at time T, CUSUMSQ=1.

The CUSUM or CUSUMSQ statistics are plotted against time along with upper and lower confidence limits. Movements of the test statistics outside the confidence bands indicates that the parameters are not constant over time.

Data Description

Monthly data for the period January, 1978 to June, 1996, a total of 222 monthly observations, were used in this study. Monthly import price of Mexican tomatoes expressed in dollars were calculated using the quantity and value data from United States import history obtained from the Bureau of Census, Department of Commerce.

Monthly import price for substitute fresh tomatoes, defined as the weighted price of tomatoes imported from Canada, the Dominican Republic and the Netherlands, were also calculated using data from the United States import history obtained from the Bureau of Census, United States Department of Commerce.

Monthly shipping point prices for domestic fresh tomatoes were obtained from the vegetable price series (United states monthly and season grower price) published by the National Agricultural Statistics Service (NASS) of the USDA. The three tomato price series were converted to real prices by dividing each by the fresh vegetable producer price index obtained from the Bureau of Labor Statistics (BLS). All the tomato price series were expressed in 1988 dollars (1988=100).

The Mexican share of the fresh tomato market was calculated as a proportion of apparent domestic consumption. Apparent domestic consumption was calculated as the sum of (a) imports from Mexico, Canada, Dominican Republic and Netherlands; (b) Florida supplies; and (c) supplies from other domestic sources. Shipments from Florida and other domestic origins were calculated from the annual issues of "fresh fruit and vegetable shipments by commodities, states and months" published by the Agricultural Marketing Service (AMS).

The bilateral exchange rate (pesos per dollar) was obtained from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). The real bilateral rate was calculated using the procedure described by Edwards (1988, pp.52-56). The real exchange rate is defined as ERR=(E)(WPI/CPI), where E is the peso-dollar exchange rate, WPI is the domestic wholesale price index and CPI is the Mexican consumer price index. Because approximately 70 percent of Mexico's international trade and all tomato trade is with the United States a bilateral rate was deemed suitable.

Mexican minimum wage (pesos/day) and the index of Mexican producer price index were obtained from the International Financial Statistics (IFS) of the International Monetary Fund (IMF). These two series were used to construct a Mexican real wage (1988=100) series. The real United States income (1988=100) was derived by dividing the unseasonalized domestic personal income by the domestic consumer price index (CPI) for all commodities. The former was obtained from the gross domestic product and components of the Federal Reserve Bank of St. Louis. The United States CPI was obtained from the IFS of the IMF.

Real tariff (pesos/box) was calculated as the weighted average tariff using the monthly tariff rates weighted by weekly Mexican fresh tomato import quantities. The fresh tomato quantities were obtained from "Marketing West Mexico Vegetables," while the tariff rates came from the Foreign Agricultural Service (FAS) Fact Sheet on NAFTA. The real tariff rate was calculated by converting tariffs from dollars into pesos using the appropriate peso-dollar exchange rates. Tariffs in pesos were then converted to real values (1988=100) using the Mexican producer price index. This definition of tariff represents its real cost to Mexican exporters. Frost variables were constructed assuming that freezes in December, January and

February affect supplies in December through April, January through April and February through June, respectively. These assumptions were based on planting and the most active harvesting times for fall, winter and spring tomatoes. A month with a crop damaging freeze was defined as having temperatures below 24 degrees fahrenheit for more 8 hours in any day.

CHAPTER 5

EMPIRICAL RESULTS AND DISCUSSION

Empirical Results

Results regarding the order of integration, cointegration and parameter estimates for tomato import price functions and the market share equation are presented in the first section of this chapter. Outcomes of the stability analysis and tests of the principal hypotheses are discussed in the second section.

Order of Integration Test Results

The issue of stationarity of variables included in the estimations was examined using the Dickey-Fuller (DF) and Augmented Dickey-Fuller (ADF) test procedures. Three minor modifications of equations (33) and (34) were necessary to classify the respective series. An equation of the form $\Delta y_t=\alpha+\beta y_{t-1}+e_t$ adequately described the data generating process for real Mexican import price (LRMP), real substitute price (LRSP), real domestic shipping point price (LRUSP), Mexican market share (LMXSH) and real tariff (LRTF). Real exchange rate (LREX) was suitably categorized by an equation without intercept or trend, i.e., $\Delta y_t=\beta y_{t-1}+e_t$. Real total domestic income (LRY) and real Mexican daily wage rate (LRWGE) were appropriately characterized by an equation with an intercept (α) and trend (δ), i.e., $\Delta y_t=\alpha+\delta t+\beta y_{t-1}+e_t$.

Order of integration results are summarized in Table 5. In general, the null hypothesis of nonstationarity was rejected by both the DF and ADF tests at significance levels of 5 percent or better for LRMP, LRSP, LRUSP, LMXSH, LRTF and LREX. However, the null of nonstationarity could not be rejected for LRWGE and LRY at the 10 percent confidence level. Interestingly, LRWGE and LRY when measured as first-difference, rejected the null hypothesis of nonstationarity at the 1 percent level. Alternately, first-differencing LRWGE and LRY resulted in stationarity. These conclusions denote that LRWGE and LRY were integrated at order one, I(1), and all other variables were integrated at order zero, I(0).

Cointegration Test Results

The next prerequisite involved establishing whether import price (equation 23) and market share (equation 31) display "equilibrium tendencies" in the sense that residuals from these regressions are stationary, [I(0)]. In practice, cointegration tests should be performed to determine if LRWGE and LRY are cointegrated (Mehra, 1991, and Ahmed et al., 1993). If a cointegrated set is formed by LRWGE and LRY, then both the import price and market share equations can be estimated using ordinary least squares and the resulting coefficient estimates will be free of spurious regression problems (Mehra, 1991).

This study deviates from the general practice by adopting a more rigorous approach. Instead of confining the tests to LRWGE and LRY, all the variables in the import price and market share equations were included. Accordingly, the tests were implemented by alternating the dependent variable. This framework circumvents any presumption that one of the seven variables in each equation is preferred to any other in performing the tests.

Table 5. Order of integration results for series used in tomato import price and market share equations

Variable Names	DF Test		ADF Test	
	Levels of variables	First difference	Levels of variables	First difference
LRMP[a]	-0.3553*** (-6.8992)		-0.5777*** (-7.2037)[d] [4][d]	
LRSP[a]	-0.5909*** (-9.6734)		-0.4718*** (-5.3620) [3]	
LRUSP[a]	-0.5889*** (-9.5681)		-0.7281*** (-7.0846) [3]	
LMXSH[a]	0.3475*** (-6.8406)		-0.5585*** (-7.8330) [3]	
LRTF[a]	-0.2265*** (-5.2542)		-0.1115* (-2.5812) [2]	
LREX[b]	-0.0054** (-2.3708)		-0.0042* (-1.8491) [2]	
LRWGE[c]	-0.0287[NS] (-1.5506)	-0.0755[NS] (-2.4375)	-0.0169[NS] (-1.3657) [13]	-0.0925*** (-4.3019) [14]
LRY[c]	-0.0163[NS] (1.5343)	-0.02589[NS] (-1.6558)	-0.0363** (-2.9348) [13]	-0.0588*** (-6.8657) [13]

[d] Figures in parenthesis () are t values, those in square brackets [] optimal lag lengths.
[NS] Denotes not significant at the 10 percent level.

[a] For equations with intercept but no trend critical values are:***=1% (-3.46), **=5% (-2.87.43) and *=10% (-2.57).

[b] For equations without intercept or trend critical values are:***=1% (-2.58), **=5% (-1.95) and *=10% (-1.62).

[C] For equations with intercept and trend critical values are:***=1% (-4.00), **=5% (-3.43) and *=10% (-3.14).

Results for the import price and market share cointegrating equations, with alternating dependent variables, are summarized in Table 6. The Dickey and Fuller (1987) test was utilized to determine if the seven variables formed a cointegrated set. This entailed verifying that residuals from all regressions were I(0).

The null hypothesis of noncointegration was rejected for the import price as well as the market share cointegrating equations at the 5 percent confidence level or better. This conclusion was invariant to the choice of dependent variable. This unified result is interesting for three reasons. First, a known drawback of this Engle and Granger (1987) procedure is that it can produce conflicting results depending on choice of dependent variable. Since our results were robust with respect to this factor, this disadvantage is inconsequential.

Second, the definitive conclusion that all variables (in each equation) formed a cointegrating set implies the existence of an adjustment process which prevents residuals in the respective long run relationship from deviating excessively over time. Finally, Engle and Granger (1987) showed that any cointegrated series must have an error correction representation. These considerations validate our proposed error correction estimation approach. The above results are not surprising despite our finding that some variables were I(0) and others I(1). Charemza and Deadman (1992, p.148) suggested the guide that when some variables in a cointegrating equation are of different orders of integration, if the order of integration of the dependent variable is lower than the highest order of integration of the explanatory variables, there must be at least two explanatory variables integrated of this highest order if the necessary condition for stationarity of the error terms are to be met. Both cointegrating equations conformed to this condition.

Table 6. Cointegration tests for variables in tomato import price and market share equations

Regression with dependent variable as	Import price equation	Market share equation	Cointegration status[c]
	Coefficient[a]	Coefficient[b]	
LRMP	-0.4447 (- 7.9277)	-0.4640 (-8.2216)	yes
LMXSH		-0.4668 (-8.3037)	yes
LRSP	-0.7057 (-11.1002)[d]		yes
LRUSTP	-0.6409 (-10.1880)	-0.6633 (-10.4455)	yes
LRWAGE	-0.5719 (- 9.3265)	-0.4636 (-8.0842)	yes
LREX	-0.5177 (- 8.6957)	-0.6214 (-8.6214)	yes
LRTAF	-0.8310 (-12.3918)	-0.7083 (-11.0027)	yes
LRY	-0.1231 (- 5.7991)	-0.5261 (8.8783)	yes

[a] Coefficient on lagged residual term in import price equation.
[b] Coefficient on lagged residual term in market share equation.
[C] Critical values for 6 independent variables at 5 percent significance level is -4.7825.
[d] Figures in parenthesis () are t-values.

Parameter Estimates of the Import Price Models

Parameter estimates for the three tomato import price equations are reported and discussed in this section.

Results of the Two-step Procedure

Coefficient estimates and associated standard errors as well as selected regression diagnostics for the standard long run model (equation 23) and the dynamic restricted error correction model (DRECM) (equation 25) which comprise the Engle and Granger (1987) two-step estimation strategy are summarized in Table 7.

The DRECM is an autoregressive distributed lag (ADL) representation which yielded short run elasticities and facilitates the calculations of corresponding long run elasticities using the adjustment coefficient. For example, the long run elasticities in Table 7 were obtained by dividing each short run coefficient by the adjustment coefficient (θ), where θ=1-d and d is the sum of coefficients of lagged dependent variables in the model as explanatory variables. Some interesting features are highlighted in Table 7.

First, in the DRECM the long run estimates were generally larger compared to those for the short run. Also, excluding first [ΔLREX(-1)] and second [ΔLREX(-2)] lags on the real exchange rate all short and long run coefficients had expected signs. Second, contrasting the long run coefficients of the standard model with those of DRECM, all coefficients exhibited the expected signs, except for substitute price (LRSP) in the standard model. In addition, excluding real wage (ΔLRWGE), the estimates of DRECM were generally larger. Third, tariff and exchange rates merit special emphasis. Exchange rate pass-through (-0.656)

Table 7. Estimated coefficients for tomato import price: the standard long run and dynamic restricted error correction models

Explanatory variables	Standard long run model	DRECM	
		Short run	long run
Constant	-13.761^{***} (4.984)		
ΔLRMP(-1)		0.259^{***} (0.064)	
ΔLRMP(-2)		0.139^{**} (0.064)	
LRSP	-0.039^{NS} (0.076)		
ΔLRSP		0.054^{NS} (0.053)	0.089^{NS} (0.089)
LRUSP	0.256^{***} (0.064)		
ΔLRUSP		0.175^{***} (0.044)	0.290^{***} (0.091)
LRWGE	0.449^{***} (0.119)		
ΔLRWGE		0.217^{*} (0.180)	0.360^{NS} (0.309)
LRY	1.678^{***} (0.626)		
ΔLRY		3.572^{*} (2.445)	5.934^{*} (4.165)
LRTF	0.340^{***} (0.127)		
ΔLRTF		0.072^{NS} (0.094)	0.120^{NS} (0.154)
ΔLRTF(-1)		0.119^{NS} (0.113)	0.199^{NS} (0.182)

Table 7. --Continued:

Explanatory variables	Standard long run model	DRECM	
		Short run	Long run
ΔLRTF(-2)		0.276^{***} (0.118)	0.459^{***} (0.192)
ΔLRTF(-3)		0.318^{***} (0.114)	0.528^{***} (0.189)
ΔLRTF(-4)		0.127^{*} (0.099)	0.212^{*} (0.165)
∑(ΔLRTF)		0.914^{***} (0.375)	1.518^{***} (0.599)
LREX	-0.657^{***} (0.120)		
ΔLREX		-0.322^{NS} (0.289)	-0.536^{NS} (0.482)
ΔLREX(-1)		0.243^{NS} (0.281)	0.404^{NS} (0.481)
ΔLREX(-2)		0.229^{NS} (0.276)	0.382^{NS} (0.467)
ΔLREX(-3)		-0.592^{**} (0.285)	-0.984^{**} (0.509)
∑(ΔLREX)		-0.442^{NS} (0.448)	-0.734^{NS} (0.737)
RESID(-1)		-0.596^{***} (0.066)	

*** indicates (%); ** (5%) and * (10%) significance level, respectively.
NS indicates significant at greater than 10 percent.

Diagnostics: standard long run model

Adj. R-squared	= 0.172	F-statistics	= 8.645
JB statistic	= 19.573	DW	= 0.901
White's HT(m=26)	= 34.149	SER	= 0.370

Diagnostics: DRECM model

Adj. R-squared	= 0.357	F-statistics	= 8.998
JB statistic	= 6.901	Durbin's h	=-1.595
SER	= 0.275	Q(4)statistic	= 2.793
White's HT(m=141)	=158.855	BG LM(4)	= 4.483

for the standard model was slightly smaller than the sum of those in the long run portion of DRECM (-0.734). Similarly, the cumulative long run tariff pass-through (1.518) in the DRECM was more than four times larger relative to that in the standard model.

Fourth, several aspects of the regression diagnostics deserve emphasis. Residuals of the standard model exhibited evidence of first-order autocorrelation (DW=0.901 < dl=1.697). This may be an indication of misspecification arising from omitted variables. In contrast, the Ljung and Box (1979) test statistic [Q(4)=2.474] for DRECM showed no evidence of serial correlation. Furthermore, the null of heteroscedasticity in the standard and the DRECM, based on White's test could not be rejected at the 10 percent level. Standard error of the (SER) regression in the standard model [0.374] was 25 percent higher relative to the DRECM [0.277], reflecting that the latter is an improved specification over the former. In addition, the adjusted R^2 was better in the DRECM (0.35) compared to the standard model (0.16). The Bera and Jarque (1982) normality test (a χ^2 test with 2 degrees of freedom) did not reject the null hypothesis that the errors in the two regressions were normally distributed. Finally, as expected, the error correction term of the DRECM was negative and highly significant, indicating that its omission would have biased the estimates.

Banarjee et al.(1986) criticized the two-step estimation strategy arguing that inclusion of the error correction term imposed restrictions on the estimated coefficients of the DRECM. Mehra (1991) also criticized the two-step procedure demonstrating that the error terms from the standard model could be serially correlated or heteroscedastic, making standard tests invalid. Both authors suggested estimation of an unrestricted model to overcome the limitations of the two-step technique. In light of these considerations, plus the result that

heteroscedasticity and autocorrelation are found in Table 7, an unrestricted dynamic error correction model (UDECM) was estimated.

Unrestricted Dynamic Error Correction Model

Results for the unrestricted or combined dynamic error correction (UDECM) version of the tomato import price (equation 27) are reported in Table 8. The parameter estimates obtained from the short run segment of the model may be interpreted as direct partial short run impacts. The corresponding estimates from the long run section of the model are shown as un-adjusted and adjusted. The adjusted estimates were calculated by dividing each actual coefficient by the error correction coefficient [$LRMP_{t-1}$]. It is emphasized that the cumulative short run elasticities may not equal the actual or adjusted long run elasticities. This is because no constraints requiring them to be equal were imposed in the model. In this regard, the estimation approach is similar to those of Carruth and Schnabel (1990) and Mehra (1991).

Prior to discussing pass-through elasticities, several comments regarding diagnostic properties merit comparison with those of the two-step estimation technique. This comparison is essential because the purpose of estimating both models is to choose the one which performs best, and utilize it for subsequent detailed analysis.

Similar to the DRECM, no evidence of serial correlation was found by the equivalent tests. However, unlike the DRECM, heteroscedasticity was not detected in the UDECM. Specifically, White's test signifies lack of heteroscedasticity problems. Additionally, the Bera and Jarque (1982) test statistic [7.169,df=2] confirmed normality of the residuals. Standard error for the UDECM regression (SER=0.28) was equivalent to that of the DRECM (0.28).

Table 8. Parameter estimates for the tomato import price based on the unrestricted error correction model (UDECM)

Explanatory variables	Panel A: short run	Panel B: long run	
		Un-adjusted	Adjusted
Constant	-9.9433** (4.5332)		
ΔLRMP(-1)	0.2583*** (0.0693)		
ΔLRMP(-2)	0.1358** (0.0677)		
$LRMP_{t-1}$		-0.6030*** (0.0709)	
$LRSP_{t-1}$		-0.0302^{NS} (0.0779)	-0.0501^{NS} (0.1285)
ΔLRSP	0.0504^{NS} (0.0662)		
$LRUSP_{t-1}$		0.1648*** (0.0616)	0.2733*** (0.1027)
ΔLRUSP	0.1794*** (0.0536)		
LRY_{t-1}		1.1798** (0.5519)	1.9564** (0.8775)
ΔLRY	3.5945* (2.5911)		
$LRWAGE_{t-1}$		0.3552*** (0.1510)	0.5889*** (0.2319)
ΔLRWAGE	0.2388^{NS} (0.1989)		
$LRTF_{t-1}$		0.3394** (0.1862)	0.5628** (0.2942)
ΔLRTF	0.1092^{NS} (0.1085)		

Table 8. --Continued:			
Explanatory variables	Panel A: short run	Panel B: long run	
		Un-adjusted	Adjusted
ΔLRTF(-1)	0.04647^{NS} (0.0467)		
ΔLRTF(-2)	0.2230^{*} (0.1521)		
ΔLRTF(-3)	0.2759^{**} (0.1385)		
ΔLRTF(-4)	0.0977^{NS} (0.1099)		
∑(ΔLRTF)	0.7525^{**} (0.4799)		
$LREX_{t-1}$		-0.4917^{***} (0.1642)	-0.8154^{***} (0.2432)
ΔLREX	-0.3489^{NS} (0.3039)		
ΔLREX(-1)	0.2984^{NS} (0.3205)		
ΔLREX(-2)	0.2651^{NS} (0.3168)		
ΔLREX(-3)	-0.5511^{**} (0.3172)		
∑(ΔLREX)	-0.3365^{NS} (0.6411)		

*** indicates (1%); ** (5%) and * (10%) significance level, respectively.
^{NS} indicates not significant at above 10 percent

Regression diagnostics:

Adj. R-squared	= 0.336	BJ-stat	= 7.169
F-statistic	= 5.971	BG LM(4) test	= 3.847
Durbin's h	=-1.489	Q(4) statistic	= 2.637
SER	= 0.279	Nobs.	= 217

Consistent with the general-to-specific estimation strategy, an exercise was carried out to determine if the estimated model in Table 8 could be reduced. The respective hypothesis that the first [calculated $F(3,198)=5.784$] and second set of lags [calculated $F(3,198)=3.580$)] were jointly zero was rejected at the 5 percent level; therefore, these lags were not deleted. Similarly, the null that the third set of lags was jointly zero [calculated $F(2,198)=2.963$] was rejected at the 10 percent level; therefore, they were not deleted.

Joint tests on each set of explanatory variables (lags included) were also conducted. The first and second lags on changes in Mexican import price (ΔLRMP) were significantly different from zero [calculated $F(2,198)=7.293$], hence they were kept in the model. The set of exchange rate variables were different from zero only at the 25 percent level of significance [calculated $F(4,198)=1.67418$]. However, they were not deleted because the third lag was significant ($p=0.05$). Furthermore, theory suggests that they be included. Also, the set of 5 tariff variables were not significantly different from zero [calculated $F(5,198)=1.54514$]. Again, these variables were kept in the model because at least 2 were statistically different from zero ($p=0.05$).

In conclusion, the unrestricted error correction model was considered superior to the two-step technique primarily because of absence of heteroscedasticity and autocorrelation. Since the goal of this study is to test hypotheses about the parameters of the import price equation it is important to have residuals that are well behaved (Mehra, 1991). Having selected the unrestricted model (Table 8), all subsequent analyses with respect to the tomato import price equation are based exclusively on this choice.

Pass-through of substitute tomato price. Short run substitute tomato price coefficient (ΔLRSP) exhibited the expected sign, while the long run coefficient ($LRSP_{t-1}$) displayed the incorrect sign. However, both were insignificant at the 10 percent level. This variable was measured as a weighted average of Canadian, Dominican Republic and Netherlands fresh tomato prices. The observed insignificance or lack of substantial cross-price influence may be attributed to the small quantities of fresh tomatoes originating from these sources. This is plausible, given that over the past 19 years fresh tomatoes from these sources averaged less than 2 percent of apparent domestic consumption.

Pass-through of domestic tomato price. The elasticity of Mexican tomato import price with respect to domestic producer shipping point price in the short (ΔLRUSP) and long run ($LRUSTP_{t-1}$) displayed the correct signs and were significant at the 1 percent confidence level. The short run magnitude indicated that a 1 percent increase in domestic shipping point price will boost Mexican import price by approximately 0.18 percent. The corresponding long run magnitude indicated an impact of 0.27 percent. Absence of lags on this variable confirms that only current domestic price exerted an important influence on Mexican fresh tomato import prices. Short and long run coefficients were statistically different from unity, implying incomplete pass-through.

Pass-through of domestic income. Pass-through of real domestic income in the short run (ΔLRY) was significant at the 10 percent level and displayed the expected sign. Its size indicates that a 1 percent increase in real domestic income caused Mexican tomato import price to rise by 3.6 percent. The parallel long run (LRY_{t-1}) magnitude was half that of the short run (1.96 percent). The short run estimate (3.6) seems unrealistic, while that for the

long run (1.96) may be high but more reasonable. Theoretically, consumer spending is not influenced substantially by short run income changes, but by permanent changes in income. Therefore, the long run estimate is more suitable for policy purposes.

Pass-through of real Mexican wage. Short run changes in real Mexican wage rate (ΔLRWGE) in pesos per day, as expected, were positive and statistically significant at the 12 percent level. Its magnitude signifies that a 1 percent rise in the real cost of Mexican labor caused Mexican tomato import price to adjust upward by 0.24 percent; however, the long run impact grows to 0.59 percent. Short- and long run coefficients were significantly different from unity, implying incomplete pass-through of adjustments in the real wage to Mexican tomato import prices. Statistical insignificance of lags (not reported) on real wage denotes that current real labor cost is one factor influencing Mexican fresh tomato import price.

Pass-through of real tariff rates. Each of the tariff coefficients (ΔLRTF) may be interpreted as a partial short run direct elasticity. Their sum measures the total direct effect of changes in tariff, excluding any indirect impacts which may occur through factor or competing product markets.

The short run estimates imply that approximately 5 months (current month plus 4 monthly lags) were sufficient to achieve a cumulative pass-through in the order of 75 percent. In other words, a 1 percent decline in tariff rate would increase Mexican fresh tomato import price by an estimated 0.75 percent. The analogous long run response ($LRTF_{t-1}$) was 0.56 percent. The cumulative short run estimate was not statistically different from unity (p=0.05), indicating complete short run pass-through. On the other hand, the long run coefficient, 0.56, was statistically different from unity indicating incomplete pass-through. These results have

several explanations. First, given the intensely competitive environment of the fresh tomato trade, it is possible that Mexican exporters are reluctant to completely pass-through changes in tariff in the long run, but may do so in the short term. For example, a reduction in tariff should reduce Mexican marketing costs and translate into a lower import price. However, if import prices are already low due to other factors (e.g., peso devaluation), lowering the price further may invoke a protectionist response from domestic competitors.

Second, in the short run the quantity available for export is fixed and perishable; therefore, Mexican producers would be willing to reduce price to market available supply. Furthermore, in the short run Mexican exporters may be pressured to fully pass-through cuts in tariff rates to their domestic importers because the customers of the importers are aware of tariff rate reductions and expect lower prices.

Third, in the long term Mexican supplies can be adjusted, thereby negating the impact of tariff on price. For example, strategies such as PAQs and VERs have been used to manage supply. Fourth, the Mexican industry uses a dual market optimization strategy which compares prices in the major Mexican cities with those at the United States ports of entry. By regulating the quantities shipped to each market (domestic and export) the strategy minimizes large price swings (Plunkett, 1996).

Pass-through of real exchange rate. Similar to the case of tariff, each real exchange rate coefficient (ΔLREX) can be interpreted as a partial short run direct elasticity. Their sum represents an assessment of the total direct elasticity, holding constant any indirect effects occurring through factor or competing product markets.

The short run portion of the model shows that the current month pass-through (-0.35) was significant at the 12 percent level with the expected sign. The first (0.29) and second (0.27) monthly lags had wrong signs in terms of expectations and were not significant. However, the third lag (-0.55) was highly significant with the expected sign. The cumulative short run estimate [$\sum(\Delta LREX)$=-0.34] exhibited the expected sign and was significantly different from unity. In other words, about 4 months elapsed before a 1 percent depreciation of the real peso-dollar exchange rate translates into a 0.34 percent reduction in tomato import prices. Furthermore, extending lags on the real exchange rate beyond 3 months resulted in coefficients which were statistically insignificant and inconsequential in magnitudes.

The positive and negative coefficients on the exchange rate may be due to short run imperfection in information and habit persistence which prevent fresh tomato exporters in Mexico and their domestic importers from making "optimal" short term price adjustments. For example, uncertainties associated with the duration of real exchange rate changes might cause exporters to adopt a wait-and-see attitude before adjusting prices.

On the other hand, the long run exchange rate transmission (-0.81) was significant (p=0.01) and not statistically different from unity, implying complete pass-through. This confirms that with time, increased information flows corrected the inefficiencies which might have existed in the short run.

Long Run Mexican Market Share Results

Results of the estimated Mexican market share model (equation 31) are reported in Table 9. The unadjusted parameters are the ordinary least squares estimates after correcting

Table 9. Mexican market share results from the estimated Logistic regression model

Explanatory variables	Un-adjusted coefficients	Adjusted coefficients
TIME	-0.0229*** (0.0086)[a]	0.0175*** (0.0066)
DFROST	-0.3363* (0.2174)	0.2575* (0.1664)
JFROST	-0.6729*** (0.2253)	0.5152*** (0.1725)
FFROST	-0.1494[NS] (0.2365)	0.1144[NS] (0.1811)
WINTER DUMMY	0.4129*** (0.1516)	0.3161*** (0.1161)
LRMP	-0.5933*** (0.1843)	-0.4542*** (0.1411)
LREX	1.0419*** (0.4338)	0.7976*** (0.3321)
LRWGE	-1.7434*** (0.4853)	-1.3347*** (0.3715)
LRY	1.1479* (0.8481)	0.8788* (0.6493)
LRTF	0.4812** (0.2707)	0.3684** (0.2072)

[a] Standard errors in parenthesis ()
*** Significant at the 1 percent level
** Significant at the 1 percent level
* Significant at the 1 percent level

Adj R^2	= 0.5646
DW statistic	= 1.8583
White's Het. test statistic	= 92.676***
BJ test statistic	= 11.3118***
ARCH test statistic	= 46.0819***
F-Stat (zero slopes)	= 12.0864***

for autocorrelation with the Hildreth-Lu procedure. These parameters do not have the usual ordinary least squares interpretation. However, the adjusted parameters can be interpreted as the percentage change in Mexican share of apparent United States consumption with respect to a corresponding percent change in any of the explanatory variable.

Time, included as a proxy for technical change, was positive and significant at the 1 percent level. The dummy variables DFROST, JFROST and FFROST were included to capture the effects of crop damaging freezes on domestic shipping point prices during December, January and February, respectively. All the frost coefficients had the expected positive sign; however, only December and January frost [DFROST, JFROST] parameters were significantly different from zero ($p=0.05$). The winter dummy variable defined as the seven months from November to May captures the impact of the winter season on Mexican market share. This variable was positive, as expected, and highly significant ($p=0.05$).

The elasticity of Mexican market share with respect to Mexican selling price (-0.45) was negative, highly significant and statistically different from unity; therefore, implying incomplete pass-through. Its magnitude indicates that a 1 percent rise in Mexican selling price would be accompanied by 0.45 percent decline in their share of the domestic fresh tomato market.

Real exchange rate transmission to Mexican market share (0.79) had the expected positive sign, highly significant and not statistically different from unity; thus, indicating complete pass-through. Specifically, a 1 percent depreciation of the real peso-dollar exchange rate caused an increase of approximately 0.79 percent in Mexico's market share.

The elasticity of Mexican market share with respect to changes in real Mexican wage rate (-1.33) was highly significant and also not different from unity, indicating complete pass-through. Alternately, a 1 percent increase in Mexican real wage rate reduced their market share proportionately. This result is especially consistent with the view that declining real wages in Mexico gives their producers an advantage in the domestic market.

The responsiveness of Mexican market share to changes in real domestic income (0.88) was positive, as expected, and not significantly different from unity; suggesting complete pass-through. That is, a 1 percent growth in real domestic income increased the Mexican share of the domestic market by 0.88 percent.

Finally, the elasticity of Mexican market share to adjustments in real tariff rates (0.37) carried the expected sign and was significantly different from unity; therefore, implying incomplete pass-through. The results indicate that a 1 percent decrease in the real tariff rate increased Mexican share of the United States market by 0.37 percent.

Stability Analysis and Tests of Hypotheses

This section extends the previous results and discussion in two directions. First, stability of the pass-through relationships is examined. Second, the principal hypotheses of the study are tested. The conclusions drawn from these tests form an essential component of the policy implications discussed in the final chapter.

Stability Analysis

The possibility of breaks in the estimated relationships was evaluated using cumulative sum of squares (CUSUMSQ) tests. If breaks occurred, they were investigated to identify

possible association with appreciation or depreciation of the peso. A measure of depreciating or appreciating real peso-dollar exchange rate was defined as the purchasing power parity (PPP) exchange rate divided by the observed nominal rate. A PPP ratio exceeding unity signifies peso appreciation or overvaluation. A PPP ratio below unity implies depreciation or undervaluation.

Figure 3 shows a plot of time (in months) versus CUSUMSQ, mean of CUSUMSQ, the 5 percent upper and lower bounds on CUSUMSQ and the PPP ratio. A positive relationship (0.61802) existed between the PPP ratio and the CUSUMSQ. Specifically, the periods April, 1981 to October, 1984 and November, 1991 to June, 1996 coincided with real peso-dollar exchange rate appreciation and a stable pass-through relationship. In contrast, November, 1984 to October, 1991 represented a period of real peso-dollar exchange rate depreciation and a protracted break in the pass-through relationship.

Formal analysis of the observed instability of the estimated relationships was confined to these two exchange rate episodes. The Chow test was applied to test the hypotheses that the coefficient estimates and variances in these two sub-periods were equal [H_0:$\beta_1 = \beta_2$ and $\sigma_1^2=\sigma_2^2$]. The null hypothesis of equal variances [H_0:$\sigma_1^2 = \sigma_2^2$] was not rejected (p=0.05); therefore, equality of coefficients [H_0:$\beta_1 = \beta_2$] for the two sub-periods was evaluated. This hypothesis was rejected (p=0.05), confirming that at least some of the coefficients from the currency depreciating and appreciating periods were different [$\beta_1 \neq \beta_2$], as opposed to all the coefficients being different.

Coefficient estimates for currency depreciation and appreciation periods are presented in Table 10 to provide comparison of their magnitudes. These estimates should be cautiously

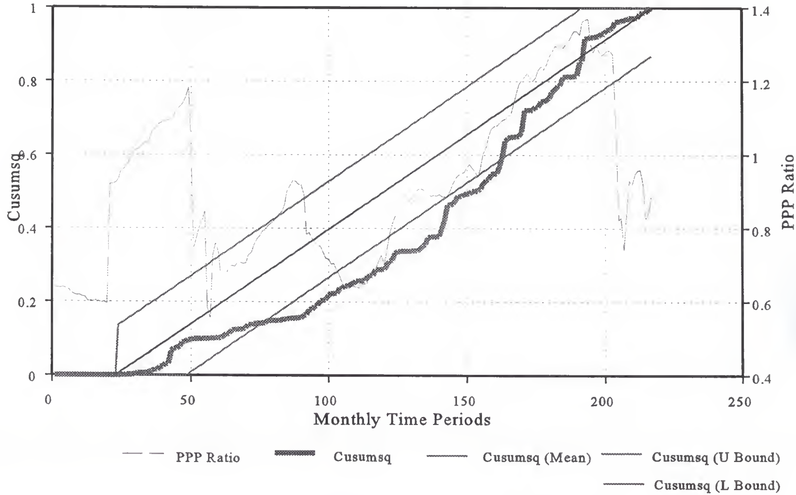

Figure 3. Plots of Time in months Versus Cusumsq Statistics and PPP Ratio

Table 10. Estimated coefficients for episodes of real peso depreciation versus appreciation and open market period

Explanatory variables	Peso depreciation	Peso appreciation	Open market period
Panel A: short run estimates			
Constant	-12.0754 (5.9204)	-9.4714 (14.2268)	-14.0122 (8.2382)
ΔLRMP(-1)	0.2332 (0.0861)	0.3326 (0.1420)	0.3177 (0.1005)
ΔLRMP(-2)	0.1134 (0.0872)	0.2936 (0.1361)	0.1282 (0.0934)
ΔLRSP	0.0027 (0.0771)	0.0990 (0.171)	0.0088 (0.1245)
ΔLRUSTP	0.2148 (0.0670)	0.1194 (0.1093)	0.2423 (0.0772)
ΔLRWAGE	0.0959 (0.2301)	0.9261 (0.5389)	0.3647 (0.3297)
ΔLREX	0.0396 (0.3758)	-0.7188 (0.6426)	-0.5225 (0.6487)
ΔLREX(-1)	0.2806 (0.3729)	0.8236 (0.8435)	-0.1817 (0.6309)
ΔLREX(-2)	-0.0251 (0.3206)	2.5316 (1.1180)	1.2585 (0.6427)
ΔLREX(-3)	-0.5676 (0.3163)	0.3013 (1.1274)	-0.5178 (0.6627)
∑(ΔLREX)	-0.2725 (0.6825)	2.9378 (2.2816)	-0.0366 (1.2222)
ΔLRTF	0.0242 (0.1279)	0.3627 (0.2688)	0.1594 (0.1911)
ΔLRTF(-1)	-0.0268 (0.1848)	-0.3282 (0.5783)	0.0209 (0.3049)
ΔLRTF(-2)	0.3270 (0.1749)	-0.1699 (0.4828)	0.1427 (0.2657)

Table 10. --Continued:			
Explanatory variables	Peso depreciation	Peso appreciation	Open market period
ΔLRTF(-3)	0.2940 (0.1634)	0.0893 (0.3766)	0.3843 (2.3768)
ΔLRTF(-4)	0.0258 (0.1634)	0.1245 (0.2735)	0.1932 (0.1952)
$\sum(\Delta$LRTF)	0.6442 (0.4928)	0.0784 (1.4883)	0.9005 (0.8435)
ΔLRY	3.1654 (2.7337)	3.5946 (2.5911)	2.9905 (4.3712)
Panel A: long run estimates			
$LRMP_{t-1}$	-0.5260 (0.0825)	-0.7706 (0.1558)	-0.8256 (0.1153)
$LRSP_{t-1}$	0.1408 (0.1604)	0.0253 (0.3183)	0.1753 (0.1734)
$LRUSTP_{t-1}$	0.4014 (0.1496)	0.2732 (0.0953)	0.3905 (0.1188)
$LRWAGE_{t-1}$	0.7025 (0.3319)	1.7296 (0.7233)	0.6239 (0.2977)
$LREX_{t-1}$	-0.9965 (0.3697)	-1.8247 (0.7315)	-0.6457 (0.2799)
$LRTF_{t-1}$	0.7654 (0.3905)	1.3546 (0.9928)	0.7320 (0.4765)
$LRYPC_{t-1}$	2.6979 (0.88140	0.9706 (2.2831)	1.9730 (1.1597)

$RSS_T = 15.180$ $\quad T_T = 217$ $\quad H_0^1:\beta_1=\beta_2$ VS $H_0:\beta_1\neq\beta_2$
$RSS_1 = 6.568$ $\quad T_1 = 136$ $\quad H_0^2:\sigma_1=\sigma_2$ VS $H_0^2:\sigma_1\neq\sigma_2$
$RSS_2 = 4.235$ $\quad T_2 = 77$
Test_Stat $(H_0^1) = 8.841$ $\quad$ Test_Stat $(H_0^2) = 1.349$
$F(54,113)\ (H_0^1) = 1.451$ $\quad F(23,171)\ (H_0^2) = 1.593$
where RSS_T, RSS_1, and RSS_2 are regression sum of squares for full, first and second period models, respectively. T_T, T_1, and T_2 are similarly defined.

interpreted given the relatively small number of observations, particularly during the peso appreciation period. In general, it is not surprising that the estimated standard errors were higher for both sub-periods relative to the full sample.

During real peso depreciation, the cumulative short run exchange rate pass-through (-0.27) was less than fully passed-through. On the other hand, exchange rate pass-through in the long run (-0.99) was significant and not statistically different from unity. Under real peso appreciation, the short run exchange rate pass-through (2.94) was positive and not significant from unity. In contrast, the long run pass-through (-1.82) was negative but more than complete.

These results demonstrate that under real peso depreciation profits in the short run were increased because most of the adjustments in the exchange rate were absorbed into profit margins. Long run changes in the real exchange rate were proportionately passed-through in order to protect market share. Further, under real peso appreciation short run profits were protected by allowing prices to rise proportionately and this caused contraction in market share. Consequently, prices were reduced more than proportionately in the long run in an effort to regain lost market share.

Table 10 also reveals that during real peso depreciation the short run passed-through of changes in the real wage rate (0.09) was inconsequential; however, for the long term it was approximately proportional (0.70). Analogously, under real peso appreciation the short run transmission of changes in real wage rate (0.93) fully passed-through; however, pass-through of changes in real wages in the long term (1.73) were more than completely passed-through.

These conclusions are consistent with the view that during episodes of real peso appreciation the Mexican fresh tomato industry, like all other export sectors, was penalized.

Table 10 indicates that real peso depreciation was associated with tariff pass-through that was significant and complete in both the short (0.64) and long run (0.77). Also, under real peso appreciation the pass-through of changes in real tariff rates (0.07) was negligible; however, for the long run it was not statistically different from unity.

Tests of Hypotheses

The first hypothesis asserts that pass-through of real exchange rate was incomplete in the short run but complete in the long run. This hypothesis was not rejected by the data. In other words, the sum of the partial direct short run exchange rate coefficients (-0.34) differed from unity at the 5 confidence level and the long run coefficient (-0.81) was not statistically different from unity (p=0.05). These findings demonstrate incomplete short run and complete long run pass-through. Complete long run exchange rate pass-through implies that Mexican fresh tomato import prices fully reflect the changes in real exchange rates. In addition it indicated efficient dissemination of information and arbitrage within the trade.

The second hypothesis asserts that the pass-through of exchange rate and Mexican labor costs changes to domestic import prices for Mexican fresh tomatoes were greater during episodes of peso devaluation and weakest during those of peso appreciation. This so-called ratchet hypothesis was rejected by the evidence.

The results confirmed the opposite situation suggested by the ratchet hypothesis for the short and long run. Specifically (i) short run transmission of exchange rate adjustments

was stronger under real peso appreciation (2.93) compared to depreciation (-0.27); (ii) long term transmission of real exchange rate adjustments was greater when the peso appreciated (-1.82) relative to depreciation (-0.99); (iii) short run pass-through of changes in the real wage rate was stronger under real peso appreciation (0.92) versus (0.09) under depreciation; and (iv) long run pass-through of changes in the real wages was greater under real peso appreciation (1.73) compared to (0.70) under depreciation.

Overall, the data furnished no evidence for accepting the ratchet hypothesis. Instead, the results indicate asymmetry in the pass-through. That is, the extent to which real domestic import prices fall when the real peso depreciates was not equivalent to the extent of their rise when the real peso appreciated. The conclusion of asymmetric pass-through reveals that the Mexican fresh tomato export industry has altered its pricing strategy in response to large adjustments in the real exchange rate.

Conventionally, during peso undervaluation if import prices fail to fall proportionately, this is generally viewed as evidence of imperfect competition, in which exporters or importers absorb part of the exchange rate variations in their profit margins (Dornbusch, 1987; Knetter, 1989). On the other hand, during overvaluation if import prices fail to rise proportionately profit margins of exporters and or importers are assumed to be reduced (Feenstra, 1989).

There could be economic forces at work which are not captured by the model. For example, different outcomes might be obtained if a variable explicitly measuring the cost of imported inputs was included in the model. The logic behind this is that when the exchange rate appreciates, costs of imported inputs in Mexico are expected to be lower (in pesos) ensuring reduced costs of production. If the goal is to increase or maintain market share,

then lower production costs are expected to be transmitted to import prices. The converse holds under real peso depreciation.

The third hypothesis contends that (a) pass-through of tariff rates to import prices was the same for the full sample and after Mexican open market reforms including NAFTA; and (b) exchange rate and tariff rate changes have equivalent effects on Mexican tomato import prices. Part (a) of this hypothesis was evaluated by testing for parameter constancy over the full sample and Mexican open market reform sub-sample. The null of parameter constancy was rejected indicating differences in parameter values across the two samples. The open market reform period which spans the period January, 1987 through June, 1996 was used instead of the NAFTA period. This can be justified on the grounds that (a) NAFTA is nested within this sub-period, accordingly, it may be difficult to separate both effects; and (b) the observations on NAFTA are small relative to the number of explanatory variables.

Parameter estimates for the open market reform period are displayed in Table 10. Pass-through of short run changes in tariff rates were 0.90 and 0.75, for the market reform period and full sample, respectively. Both were significant and statistically not different from unity. The corresponding pass-through of long run changes in tariff rates for the market reform period (0.73) was significant and not different from unity, while that for the full sample (0.56) was significant and different from unity. Overall, the evidence rejected the null of equality of tariff rate pass-through for the two periods. This is not surprising given that real tariff rates have declined approximately 40 percent since NAFTA. The null hypothesis that exchange rates and tariff changes have identical short run effects could not be rejected at the 5 percent level. However, the equivalence of long run exchange rates and tariffs was rejected.

The fourth hypothesis contends that Mexico has not increased its market share because of real exchange rate devaluations. The available evidence rejected this hypothesis. In particular, a 1 percent depreciation (appreciation) of the real peso-dollar exchange rate resulted in a 0.79 percent increase (decrease) in Mexico's share of the United States market.

Comparison with Other Studies

The only pass-through study which examined the United States-Mexico fresh tomato industry and is somewhat comparable with the present study is that of Bredahl et al.(1983). They estimated long run pass-through elasticities using an LOP framework. Strictly speaking, only the long run estimates from the current study can be compared to Bredahl et al.(1983). Bredahl et al. (1983) obtained elasticity estimates of 0.53 for Florida price compared to 0.27 in the current study. Their estimate could be high because only two explanatory variables were included in their investigation. In other words, if Florida price increases by 1 percent, Mexican price increases by only about half as much. This estimate is much less than unitary elasticity dictated by the LOP. Their elasticity of Mexican price with respect to exchange rate indicates that a 1 percent devaluation of the peso increased Mexican tomato price by 1.16 percent. However, this estimate was not statistically different from unity, making it similar to that obtained in the present study.

CHAPTER 6

POLICY IMPLICATIONS AND CONCLUSIONS

Policy Implications

Agricultural prices and output response are sensitive to changes in macroeconomic instruments which include, among others, exchange rates, trade restrictions or liberalization, financial markets, monetary and fiscal policies. These policy instruments exert substantial influence on the distribution of commodity market shares among trading partners. Changes in market shares in turn determine the level of employment, real rural income and the capacity of the agricultural sector to contribute to sustained economic progress.

The empirical findings of this study enhance our understanding of the determinants of import price and market share. Accordingly, they provide insights and identify issues which are critical in formulating trade policies for the tomato industry in the United States and Mexico. Although the policy concerns examined in this chapter are interrelated, clarity of presentation dictates that each be discussed separately. In addition, where it is appropriate, country specific policy issues are separated.

Impact of Real Exchange Rate Adjustments

The exchange rate pass-through phenomenon is important for analyzing the Mexico-United States trade policy concerns for two reasons. First, if adjustments in real peso-dollar

exchange rate are not completely or substantially reflected in the import prices of Mexican fresh tomatoes, the anticipated quantity or market share response will not be realized. In this respect, knowledge of pass-through serves to explain the failure of prices and trade volumes or market share to respond to adjustments in the real exchange rate. Second, investigating the issue of stability or instability of the pass-through relationship helps to explain if and how Mexican fresh tomato exporters have altered or maintained their pricing strategies in response to appreciation or depreciation of the real exchange rate.

Our empirical results established that a 1 percent real depreciation of the peso-dollar exchange rate caused Mexican fresh tomato import prices to fall by 0.34 percent. This short run price adjustment was rapid, occurring within 4 months. More importantly, the short run pass-through of real exchange rate fluctuations was incomplete. Incomplete exchange rate elasticity in the short run might be ascribed to imperfect market structure, lags in information flows and trade restrictions, namely, tariff and voluntary export restraints.

In contrast, the long run exchange rate elasticity (-0.81) was statistically not different from unity, a confirmation of complete pass-through. Complete exchange rate pass-through indicates competitive market structure, perfect information flows, and efficient arbitrage.

Overall, the real exchange rate pass-through results provide evidence for not rejecting the hypothesis that exchange rate pass-through was incomplete in the short run but complete in the long run. Additional support is furnished by the elasticity of Mexican market share with respect to real exchange rate (0.7976) being statistically not different from unity. This refutes the hypothesis that real exchange rate changes had no impact on Mexican market share. It also provided support for claims that peso devaluation reduced domestic market share.

Several policy concerns emanate from these conclusions. First, unitary exchange rate elasticity or complete pass-through indicates that Mexican tomato import prices fully reflect real exchange rate adjustments. This means peso devaluation can be construed as an export subsidy proportional in magnitude to the devaluation. Since peso devaluation affects all Mexican exports, the policy implication extends beyond the fresh tomato industry.

An important question facing the United States fresh tomato industry is, how should it respond to episodes of real peso devaluations. Objectively addressing this issue requires that policy analysts ascertain (a) if real devaluations were necessary to correct a currency misalignment problem; or (b) if real devaluations were used to secure unfair trade advantages. Although this information is desirable it is not a trivial task since it entails determination of the equilibrium real exchange rate. One possible rule is to allow a rate of peso devaluation sufficient to offset inflation differential between Mexico and the United States. That is, follow a purchasing power parity approach. Using this indicator, Dornbusch and Werner (1994) calculated that since 1988 the peso had appreciated 40 percent in real terms. The current study estimated that between 1988 and 1993 the real value of the peso had appreciated 43 percent (Table 1). This suggests that an adjustment in the peso-dollar rate was inevitable to correct the macroeconomic disequilibrium.

The second policy dilemma for the domestic tomato industry is its inability to influence Mexican macroeconomic policy (e.g., exchange rate movements). This recognition was partly responsible for the domestic industry resorting to antidumping claims. It might also influence the industry's support for innovative nontariff barriers such as food safety

legislation and country of origin labeling. It seems obvious that it is in the interest of the domestic industry to lobby for inclusion of exchange rate considerations in any future free trade negotiations.

Impact of Real Tariff Rate Adjustments

The results demonstrate that a 1 percent reduction in the real tariff rate caused a 0.75 percent reduction in Mexican fresh tomato import price after approximately 5 months. The analogous long run impact was 0.56 percent. Additionally, the elasticity of Mexican market share with respect to real tariff rate (0.37) was statistically different from unity. These results signify that pass-through of real tariff rate changes was complete in the short run but incomplete in the long run. More importantly, the hypothesis that pass-through of changes in real tariff and exchange rates were equivalent could not be rejected in the short run; however it was rejected for the long run.

The first issue of importance for policy is that changes in tariff rates can be used to counter real peso devaluations. This option was implicit in the request by Florida growers to the USITC. Between December, 1994 and March, 1995 the peso was devalued by about 54 percent. In response to this devaluation Florida growers petitioned the USITC to increase tariff rates by 50 percent.

Increasing real tariff rates to counter the negative impacts of changes in peso-dollar real exchange rate on the domestic tomato industry is attractive to domestic growers, particularly since, the tariff is commodity specific. However, increasing tariff rates on the imports of Mexican tomatoes is inconsistent with the historical stance of the United States.

Further, it conflicts with both NAFTA and the GATT/WTO agreements. One way of circumventing these conflicts is to persuade Mexican exporters to formally re-introduce voluntary export restraints (VER) and or planted area quotas (PAQ). It can be demonstrated that a tariff equivalent VER will have a similar impact on prices as a quota or tariff. Under a tariff equivalent VER, Mexico receives the rents, but rents to the United States industry expand because of higher prices.

Impact of Real Wage Rate Adjustments

Hired labor is a major cost in producing fresh tomatoes in Mexico and the United States. The minimum wage gap is currently about \$5.15 versus \$0.54 per hour in the United States and Mexico, respectively. This gap is closely related to the differential in productivity between the two countries.

The empirical results regarding real wages suggest at least five important implications for policy. First, the elasticity of Mexican tomato import price with respect to real Mexican wage was estimated at 0.24 and 0.59 for the short- and long run, respectively. Insignificance of lags imply instantaneous pass-through of changes in real wage to Mexican fresh tomato import prices. In this connection, the main policy problem for the Mexican industry is devising ways to (a) increase productivity of their work force; (b) adopt less labor intensive technologies; or (c) a combination of the two.

Second, a 1 percent rise in the real Mexican wage rate decreases Mexico's market share by 1.33 percent. This inverse relationship between market share and real wages underscores the urgency to increase the productivity of labor. This is crucial because it is not

expedient for the industry to hold real wages constant in an environment where its purchasing power is eroding. Pursuing such a policy is likely to lower existing productivity because of potential problems with malnutrition.

Third, real wage rates for low skilled labor are unlikely to increase in Mexico in the short to medium term due to excess labor supply. A more likely scenario is for real wage to stagnate or decline leading to net reduction in Mexican demand for fresh tomatoes. This will free up some fresh tomatoes for export to the United States and intensify the competition.

Fourth, a policy problem for the United States industry is that domestic wage rates will probably increase because of excess demand in the agricultural labor market. This will cause domestic shipping point prices to rise. Our results show that a 1 percent rise in domestic shipping point price will increase Mexican tomato import prices by 0.29 percent. Under this scenario, domestic production would shrink while Mexican exports expand.

Fifth, the domestic industry may experience increased production costs or reduced yield per acre due to the withdrawal of methyl bromide from the market by the year 2001. This chemical is an effective broad spectrum pesticide. To date, it is the only chemical effective against nutsedge (Deepak, et al, 1996). Reduced yield per acre is expected to cause domestic shipping point price to rise inducing a substitution of Mexican tomatoes for domestic supply. The immediate policy concern of this outcome for the United States industry in general, and the Florida industry in particular, is the urgent need to develop and adopt yield enhancing technologies which spread fixed costs over more units translating into lower costs per unit.

Impact of Real Commodity Price Adjustments

The elasticity of Mexican tomato import price with respect to domestic producers shipping point price was roughly 0.18 in the short run and 0.29 in the long run, indicating that imports are a substitute for domestic production. Absence of lags suggests that changes in domestic shipping point prices are instantaneously transmitted to Mexican tomato import prices. In addition, the elasticity of Mexican market share with respect to own price was approximately -0.4542.

Selling price is a variable that is under the control of both suppliers, therefore, it has implications for Mexico and United States industry policies. Mexican fresh tomato export growers are dependent on imported inputs. The cost of these production and marketing inputs influence selling price and profitability. Costs to Mexican growers for imported inputs include transportation, border crossing fees and Mexican import duties ranging from 10-20 percent. Under NAFTA import duties will be eliminated and transport costs may decline. These outcomes will enable Mexican exporters to reduce their selling price and capture additional market share.

Recent productivity growth in the Mexican industry achieved from extended shelf life varieties and drip irrigation have increased their supply response (Love and Lucier, 1996). In contrast, recent yield trends in the United States are flat and input costs are rising; thus, unit cost is rising (Love and Lucier, 1996). Accordingly, productivity augmenting domestic policy interventions which lower selling price will maintain or increase domestic market share. The converse is also true. If NAFTA delivers a freer trade environment, future research and development policies will dictate the nature of the competition and market share distribution.

Impact of Real Domestic Income Adjustments

Per capita income in Mexico is approximately 11 percent that of the United States. Therefore, as income grows demand for tomatoes is expected to grow much more in Mexico compared to the United States. The elasticity of Mexican tomato import price with respect to per capita domestic income was estimated at roughly 1.96 in the long run. By comparison, the elasticity of Mexican market share with respect to real domestic income was about 0.88. This implies that rising domestic income has a greater impact on increasing Mexico's market share compared to peso devaluation (0.78).

Summary

Several studies have addressed the general issue of exchange rate pass-through to import prices. These studies were motivated by empirical observations of reduced sensitivity of import prices to exchange rate adjustments. The framework for the majority of these studies has been the LOP or industrial organizations approach. These studies have evaluated either the impacts of exchange rate pass-through to import prices or on trade volumes.

In the case of the fresh tomato industry, previous studies have addressed competition between Mexico and the United States in the domestic market. These involved extensive periodic comparisons of costs among Mexico and selected producing areas of the United States. Examinations of the role of the exchange rate, however, have been less thorough. This is unfortunate since the exchange rate is fundamental in the determination of changes in import prices and market shares. In the case of the fresh tomato trade exchange rate can

potentially determine market share distributions and expectations associated with unilateral trade policies (e.g., Mexican market reforms) and multilateral trade agreements such as NAFTA.

This research sets itself apart from previous related studies in three important respects. First, it is motivated by ongoing debates regarding the causes of rising United States imports of fresh tomatoes from Mexico. The study seeks to test the validity of the popular alleged impacts of exchange rate and trade policy changes on the domestic market for fresh tomatoes. Second, a theoretical and empirical approach which is appropriate for analyzing the industry is developed. Third, a carefully selected data set is developed and used for empirically testing the model. All the data except market share were expressed in real terms because there is no unique pass-through from nominal exchange rates to product prices.

The principal questions the study attempts to illuminate include

(a) the short- and long run impact of exchange rate and cost changes on import prices and market share in the United States fresh tomato market;

(b) the short- and long run impact of tariff changes on import price and market shares in the United States fresh tomato market; and

(c) the stability of these pass-through relationships under real exchange rate depreciation and appreciation;

Conceptually, to evaluate the effects of exchange rate, tariff rate and cost changes on import prices, it is essential to go beyond the LOP as a model of import price determination. This entails incorporating features which expand the role of the firm as a strategic profit

maximizing agent. For example, under different market structures firms choose either to pass-through exchange rate, tariff and cost changes or absorb them in their profit margins.

This study employed a price setting model of import price competition. The model is appropriate for estimating exchange rate pass-through elasticity and the effects of other factors on domestic import price. Dynamics are built into the framework through an error correction mechanism which allows the data to determine the lag structure and the dynamic characteristics of the effects of each factor on import prices.

The conceptual basis for the market share model was that the movement in shares, as opposed to quantities, should be largely invariant to most demand side factors, but rather emphasize price and nonprice competition. In the market share model the dependent variable is a proportion; therefore, the bounds are zero and unity. Further, the distribution of the share variable is truncated and is not strictly normal. The logistic function is an appropriate way to model shares since it transforms the dependent variable from one bounded by zero and unity to one that is unbounded by negative and positive infinity.

The empirical model which generated the import price coefficients was based on an unrestricted error correction model. Dynamics were incorporated using an autoregressive distributed lag (ADL) structure.

Conclusions

First, the hypothesis that real exchange rate pass-through was incomplete in the short term but complete in the long term was not rejected by the statistical evidence. Specifically,

the pass-through of changes in the real exchange rate to Mexican fresh tomato import price in the short run (-0.34) was incomplete, whereas for the long run (-0.81) it was complete.

Second, instability of the pass-through estimates confirmed that Mexican exporters of fresh tomatoes employed different strategic pricing decisions to cope with episodes of real exchange rate depreciation and appreciation. For example, during periods of real peso-dollar undervaluation import prices were allowed to fall (-0.27) less than proportionately in the short run; however, in the long run import prices were permitted to fall (-0.99) proportionately.

On the other hand, for periods of real peso-dollar appreciation import prices were allowed to rise (2.94) more than proportionately in the short run. A disproportionate rise in short run import prices caused contraction in Mexican market share. In order to regain lost market shares, import prices were allowed to fall in the long run (-1.82) proportionately more than the change in real exchange rate.

In general, the tendency was for real exchange rate pass-through to be greater under appreciation relative to depreciation. Incomplete pass-through of exchange rate changes during real peso-dollar depreciation indicates expanded profits for Mexican fresh tomato exporters in the short run. In contrast, complete long run real exchange rate pass-through implies additional market share for Mexican exporters. Accordingly, with real peso-dollar depreciation Mexican fresh tomato exporters benefited from either greater profits, larger market share, or both. This conclusion is consistent with the accepted notion that real peso-dollar depreciation conveys a proportional subsidy to the Mexican fresh tomato export sector.

Interestingly, under real peso-dollar overvaluation, the short run exchange rate pass-through was either complete or more than complete. That is, Mexican exporters of fresh

tomatoes sacrificed market share to maintain short run profits. In contrast, over the long term they regained market share by reducing prices more than proportionately. These observations suggest that under real overvaluation short run profits were maintained at the expense of market share, long run market share was protected at the expense of profits, or both. This conclusion is consistent with the view that real appreciation represents a proportional tax which penalizes the Mexican fresh tomato export sector.

The real exchange rate is largely outside the control of producers in both Mexico and the United States. However, from a macroeconomic standpoint an important role for policy analysts is to ascertain if observed real exchange rate fluctuations are designed to correct misalignment or to derive unfair trade advantages.

Both industries may be proactive to ensure that issues of exchange rate fluctuations are explicitly incorporated in trade disputes or future trade negotiations. For example, in possible extensions of NAFTA to other countries safeguards for sensitive industries or sub-sectors such as tariff rates or tariff rate quotas (TRQs) could be conditional on movements in the real exchange rate.

Third, our statistical evidence refuted the hypothesis that the pass-through of real tariff rate changes was equivalent for the full, depreciating, appreciating and open market periods. Specifically, the transmission of real tariff rate changes to Mexican fresh tomato import prices was found to be asymmetric in the sense that it was

(a) complete in short run (0.75) and incomplete in long run (0.56) for the full period;

(b) complete for both short- (0.64) and long run (0.77) under real depreciation;

(c) complete for both short- (0.90) and long run (0.73) under open market; and

(d) negligible for short- (0.07) and complete in long run (1.35) under real appreciation. These asymmetric results imply that Mexican fresh tomato exporters allowed changes in real tariff rate to pass-through differentially depending on prevailing macroeconomic conditions.

Fourth, our statistical evidence failed to reject the hypothesis that the transmission of real exchange rate and tariff rate changes were equivalent in the short run; however, it was rejected in the long run. Pass-through of tariff rate changes in general, and particularly tariff rate pass-through which are equivalent to exchange rate pass-through, represent a feasible policy tool for counteracting the adverse effects of real exchange rate adjustments. The United States fresh tomato industry faces at least two policy obstacles in obtaining protection through increased tariff rates. First, increasing tariff rates is inconsistent with the United States international trade posture. Second, under NAFTA and GATT/WTO agreements tariff rates are expected to fall instead of increase.

In this context, a supply management agreement with Mexican fresh tomato exporters stands the best chance for success. Possible justifications include (a) price differentials created by supply management will accrue to Mexican fresh tomato exporters; and (b) domestic producers simultaneously benefit from higher prices which would prevail in the United States market. The downside to this option is that domestic consumers have to pay more. In other words, supply management redistributes income from domestic consumers to domestic and Mexican producers in the short run.

Fifth, the empirical analysis showed that the elasticity of Mexican fresh tomato import price with respect to changes in Mexican real wage rate was positive and incomplete in both the short- (0.24) and long run (0.59). Moreover, pass-through of the short- and long run real

exchange rate was not equivalent to those of the real wage rate. In fact, a 1 percent increase in the real wage rate causes import price to rise less than an equivalent depreciation in the real exchange rate causes import price to decrease. Accordingly, Mexican growers might choose to increase market share by lowering the dollar price of their tomatoes leaving their revenues in pesos unchanged. Such a strategy is not inconceivable given that wages constitute about a third of Mexican cost of production.

The ratchet hypothesis that the pass-through of real exchange rate and Mexican labor costs changes to import prices for Mexican fresh tomatoes are greater during episodes of peso devaluation and weakest during those of peso appreciation was rejected. The statistical evidence reveals that the transmission of short run adjustments in Mexican real wage was stronger during peso-dollar appreciation (0.92) compared to (0.09) under depreciation. Furthermore, under peso appreciation the long run pass-through (1.73) dominated that of depreciation (0.70).

Real wage is a variable which is outside the direct control of both the Mexican and domestic industries. Consequently, the respective industries are unable to suppress wages when they are rising in other sectors. Both industries should gain from investments in training which enhance labor productivity.

Fifth, the elasticity of Mexican fresh tomato import price with respect to domestic producer shipping price was (0.18) for the short term but grows to (0.27) in the long term. Absence of lags confirms that only current domestic price exerted an important influence on Mexican fresh tomato import prices. These findings indicate that if domestic shipping point price rise by 1 percent the import price of Mexican tomatoes would rise proportionately less.

Sixth, the hypothesis that Mexico has not increased its market share because of real exchange rate devaluations was rejected. In particular, the elasticity of Mexican market share with respect to the real exchange rate (0.79) was not statistically different from unity, indicating complete pass-through. That is, real peso-dollar depreciation and appreciation, respectively, increased and decreased Mexico's market share by the same magnitude. Over the 222 months in the full sample period of this study the real peso-dollar exchange rate was undervalued for 145 months or 65 percent of the time. This infers that the domestic industry has sustained substantial market share loss. On the other hand, the Mexican industry also suffered market share loss due to overvaluation, but for a comparatively shorter time span of 77 months.

Seventh, per capita income in Mexico is approximately 11 percent that of the United States. Therefore, as income grows, demand for tomatoes is expected to grow much more in Mexico than in the United States. The long run responsiveness of Mexican fresh tomato import price and the responsiveness of Mexican market share to changes in real domestic income was (1.96) and (0.88), respectively. These results have interesting implications for both suppliers. Sustained gains in real income might decrease the level of rivalry between both industries and contribute simultaneously to their expansion. Prior to the 1994 peso-dollar depreciation United States vegetable exports to Mexico were expanding in response to growing real income. The reduced purchasing power of Mexicans after the real peso depreciation led to a contraction in Mexican demand. It also made prices in the United States more attractive to Mexican producers, resulting in larger volumes of fresh tomatoes being diverted to the United States market.

Eighth, several developments are expected to reduce productivity and increase costs in the domestic fresh tomato industry. These include removal of methyl bromide from the market and increased minimum wage, labor and environmental regulations. Producers in Florida, affected by market share losses due to sustained real peso devaluation, may be expected to protect their interests using available regulatory measures. The United States government may be reluctant to interfere with the rules as they relate to NAFTA and GATT to protect domestic growers. At the very minimum, relief in the form of expanded funding for research and development aimed at reducing costs and increasing quality is desirable and should be feasible.

Overall, the research sheds light on many issues concerning the rivalry between domestic and Mexican fresh tomato producers. In addition, the theoretical and empirical framework provided is applicable for studying other commodities or industries. However, there are some areas where further work is required.

Areas for Future Research

There are several areas of refinement which might improve the results obtained. First, the results may be sensitive to the choice of the base year used to calculate real exchange rate. Accordingly, an approach which examines a range of exchange rate definitions may be useful. Furthermore all the estimates presented were based on bilateral rates. It would be interesting to see if the use of multilateral real exchange rates significantly alters these results.

Secondly, the long run market share model is static. A dynamic representation may shed more light on the adjustment towards the long run equilibrium. A model similar to the import price model may be applied to achieve this purpose.

Third, the effects of exchange rate changes on import prices are likely to depend on imported inputs and non-imported inputs. In the present analysis only tariff and wage costs were considered. An index of imported costs may be constructed and applied to determine the importance of distinguishing between imported and local inputs.

Finally, throughout the discussion the temptation to interpret the coefficients in terms of market structure characteristics has been resisted. The present model could be extended to explicitly measure the impact of market structure.

REFERENCES

Abbott, P. C., P. M. Patterson and A. Reca. (1993)."Imperfect Competition and Exchange Rate Pass-through in the Food Processing Sector." American Journal of Agricultural Economics 75:1226-30.

Ahmed, S. M., M. Hoque and S. I. Talukder. (1993)."Estimating Export Demand Function for Bangladesh: An Application of Cointegration and Error Correction Modeling." Bangladesh Development Studies 21:89-103.

Akaike, H. (1969). "Fitting Autoregressive Models for Prediction." Annals of the Institute of Statistical Mathematics 22:243-247.

Akaike, H. (1974)."A New Look at the Statistical Model Identification."IEEE Transactions on Automatic Control AC-19:716-723.

Alston, J., C. Carter and M. Whitney. (1992)."Exchange Rate Pass-Through Effects in Agriculture." In William T. Coyle, D. Hayes and H. Yamauchi (eds). Agriculture and Trade in the Pacific: Towards the Twenty-First Century. Westview Press, Boulder, CO.

Angirasa, A. and B. Davis. (1996)."Horticultural Trade Under NAFTA: Will It Hurt United States Farm Business?"Agribusiness 12:15-25.

Ardeni, P.G. (1989)."Does The Law Of One Price Really Hold For Commodity Prices?" American Journal of Agricultural Economics 71:661-69.

Arestis, P. and W. Milberg. (1993)." Degree of Monopoly Pricing and Flexible Exchange Rates." Journal of Post Keynesian Economics 16:167-188.

Athukorala, P. and J. Menon. (1994). "Pricing to Market Behavior and Exchange Rate Pass-Through in Japanese Exports." Economic Journal. 104:271-81.

Baffes, J. (1991). "Some Further Evidence on the Law of One Price: The Law of One Price Still Holds." American Journal of Agricultural Economics 73:1264-1273.

Baharumshah, A. and M. Habibullah. (1993). "Law of One Price and International Trade: Its Relevance to Malaysian Agricultural Exports." Singapore Economic Review 38:69-80.

Baldwin, R. (1988a). "Some Empirical Evidence on Hysteresis in Aggregate United States Import Prices." NBER Working Paper Series No.2483, January.

Baldwin, R. (1988b). "Hysteresis in Import Prices: the Beachhead Effect." American Economic Review 78:733-785.

Banarjee, A., J. Dolado, D. Hendry and G. Smith. (1986). "Exploring Equilibrium Relationships in Econometrics Through Static Models: Some Monte Carlo Evidence." Oxford Bulletin of Economics and Statistics 48:253-278.

Bera, A. And C. Jarque. (1982). Testing for the Normality Assumption in Limited Dependent variable models." Mimeo, Department of Economics, University of Minnesota, St Paul.

Bhagwati, J. N. (1988). The Pass-Through Puzzle: The Missing Prince from Hamlet. Columbia University, New York.

Branson, W. H. (1972). "The Trade Effects of the 1971 Currency Realignments. "Brookings Papers on Economic Activity 1:15-58.

Bredahl, M., J. Hillman, R. Rothenberg and N. Gutierrez. (1983). Technical Change, Protectionism and Market Structure: The Case of International Trade in Fresh Winter Vegetables. University of Arizona, Tucson. Technical Bulletin No.249, August.

Bredhal, M., A. Schmitz and J. Hillman. (1987). "Rent Seeking in International Trade: The Great Tomato War." American Journal of Agricultural Economics 69:1-10.

Brown, R., J. Durbin, and J. Evans. (1975). "Techniques for Testing the Constancy of Regression Relationships Over Time."Journal of Royal the Statistical Society, Series B 37:149-192.

Bureau of Labor Statistics. Fresh Vegetables Producer Price Index, United States Department of Labor, Washington, DC.

Carruth, A. and C. Schnabel. (1990). "Empirical Modeling of Trade Union Growth in Germany, 1956-1986: Traditional versus cointegration and Error Correction Methods." Weltwirschaftliches Archiv 126:327-345.

Chambers, R. G. and R. E. Just. (1981)."Effects of Exchange Rate Changes on U.S. Agriculture: A dynamic Analysis." American Journal of Agricultural Economics 63:32-46.

Charemza, W. W., and D. F. Deadman. (1992) New Directions in Econometric Practice. Edward Elgar Publishing, Brookfield, VT.

Congress of the United States, Congressional Budget Office. (1993a). Agriculture in the North American Free Trade Agreement. Washington, DC, May.

Congress of the United States, Congressional Budget Office. (1993b). Estimating the Effects of NAFTA: An Assessment of Economic Models and Other Empirical Studies. Washington, DC, June.

Congress of the United States, Congressional Budget Office. (1993c). A Budgetary and Economic Analysis of the North American Free Trade Agreement. Washington, DC, June.

Cowling, K. and R. Sugden. (1989)."Exchange Rate Adjustment and Oligopoly Pricing Behavior." Cambridge Journal of Economics 13:373-93.

Davidson, J., H. Srba, and S. Yeo. (1978). "Economic Modeling of Aggregate Time-Series Relationship Between Consumers' Expenditure and Income in the United Kingdom." Economic Journal 88:661-692.

Deardorff, A. and R. M. Stern. (1978). "The Terms of Trade Effect on Expenditure: Some Evidence from Econometric Models." Journal of International Economics 8:409-14.

Deodhar, S. Y., and I. M. Sheldon. (1995). "Is Foreign Trade Imperfectly Competitive: An Analysis of the German Market for Banana Imports." Journal of Agricultural Economics 46:336-348.

Dicky, D. and W. Fuller. (1979). "Distribution of the Estimators for Autoregressive Time Series with Unit Root." Journal of American Statistical Association 427-31.

Dicky, D. and W. Fuller. (1981). "Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root." Econometrica 49:1057-1072.

Dixit, A. (1989). "Hystersis, Import Penetration and Exchange Rate Pass-through." Quarterly Journal of Economics 54:205-28.

Dixit, A. (1984). "International Trade Policy for Oligopolistic Industries." Economic Journal Conference Papers 94:1-16.

Dolgado, J., T. Jenkins and S. Sosvilla-Rivero. (1990). "Cointegration and Unit Roots." Journal of Economic Surveys 4:249-273.

Dornbusch, R. (1987)."Exchange Rates and Prices." American Economic Review 77:93-106.

Dornbusch, R. And A. Werner. (1994). "Mexico: Stabilization and no Growth." Brookings Papers on Economic Activity 1:253-315.

Dunn, R. M. (1970). "Flexible Exchange Rates and Oligopoly Pricing: A Study of Canadian Markets." Journal of Political Economy 78:140-51.

Durham, S. E., and D. R. Lee. (1987). "An Evaluation of Alternative Approaches to Market Share Analysis: with application to the Kuwaiti Poultry Market." Journal of Agricultural Economics 38:85-97.

Dwyer, J., C. Kent, and A. Pease. (1994)."Exchange Rate Pass-Through: Testing the Small Country Assumption for Australia." Economic Record 70:408-423.

Edwards, S. (1988). Exchange Rate Misalignment in Developing Countries. Johns Hopkins University Press, Baltimore.

Emerson, L. P. (1980) Mexico's Vegetable Production for Export. USDA, Washington, DC. FAS M-297.

Engle, R. and C. Granger. (1987). "Co-Integration and Error Correction: Representation, Estimation, and Testing." Econometrica 55:251-276.

Espana, R. J. (1995). "The Mexican Peso Crisis: Impact on NAFTA and Emerging Markets." Business Economics 30:15-49.

Federal Reserve Bank of St. Louis. Gross Domestic Product and Components: United States Personal Income (Monthly). Federal Reserve Economic Data (FRED).

Feenstra, R. (1989). "Symmetrical Pass-Through of Tariffs and Exchange Rates Under Imperfect Competition: An Empirical Test." Journal of International Economics 27:25-45.

Feldman, R. A. (1982). "Dollar Appreciation, Foreign Trade and the United States Economy." Federal Reserve Bank of New York. Quarterly Review 7:1-9.

Firch, R. and R. Young. (1968). An Ecnometric Study of the Winter Vegetable Industry of Northwest Mexico. University of Arizona, Tuscon. Agricultural Experiment Station Technical Bulletin No. 179.

Florida Department of Agriculture and Consumer Services. (1996). Commissioner Crawford Hails Tomato Agreement. Press Release, Tallahassee. October 11.

Florida Tomato Committee, Annual Report. Various Years.

Froot, K. and P. Klemperer. (1989). "Exchange Rate Pass-Through When Market Share Matters". American Economic Review 79:637-654.

Gegowski, J. (1994). "The Law of One Price Revisited: New Evidence on the Behavior of International Prices." Economic Inquiry 32:407-418.

Giovannini, A. (1988). "Exchange Rates and Traded Goods Prices." Journal of International Economics 24:45-68.

Goldstein, M. (1977). "Downward Price Inflexibility, Ratchet Effects and the Inflationary Impact of Import Price Changes: Some Empirical Evidence." IMF Staff Papers 24:569-612.

Goodwin, B. K. (1992)."Multivariate Cointegration Tests and the Law of One Price in International Wheat Markets." Review of Agricultural Economics 14:117-24.

Goodwin, B. K., T. J. Grennes and M. K. Wohlgenant. (1990). "A Revised Test of the Law of One Price Using Price Expectations." American Journal of Agricultural Economics 72:682-93.

Goodwin, B. and T. Schroeder. (1991)."Cointegration Test and Spatial Price Linkages in Regional Cattle Markets." American Journal of Agricultural Economics 73:452-464.

Gould, D. M. (1995). "Mexico's Crisis: Looking Back to Assess the Future." Federal Reserve Bank of Dallas, Economic Review Second Quarter:2-12.

Granger, C. (1986). "Developments in the Study of Cointegrated Econometric Variables." Oxford Bulletin of Economics and Statistics 48:213-228.

Granger, C. and P. Newbold. (1974). "Spurious Regressions in Econometrics." Journal of Econometrics 26:1045-66.

Grennes, T. (1990). “The Link Between Financial Markets and World Agricultural Trade.” In T. Grennes (ed). International Financial Markets and International Trade. Westview Press, Boulder, CO.

Gruben, W. C. and J. H. Welch. (1994). “Is NAFTA Economic Integration.” Economic Review, Federal Reserve Bank of Dallas 35-51.

Hall, B. H., R. S. Cummings. (1995). Time Series Processor Version 4.3 Users Guide. TSP International, Palo Alto, CA.

Hammig, M. D. and R. C. Mittelhammer. (1982). "An Evaluation of Import Tariffs in the Canada-United States Fresh Tomato Market." Canadian Journal of Agricultural Economics 30:133-52.

Hendry, D. (1986). "Econometric Modeling with Cointegrated Variables: An Overview." Oxford Bulletin of Economics and Statistics 48:201-227.

Hendry, D., A. Pagan and D. Sargan. (1984). "Dynamic Specification." In Z. Griliches and M. Intriligator (eds). Handbook of Econometrics, Volume II. North-Holland, Amsterdam.

Hinojosa-Ojeda, R. and S. Robinson. (1992). "Labor Issues in a North American Free Trade: Assessing the Impact." In N. Lustig, B. P. Bosworth and R. Z. Lawrence. Brookings Institution, Washington D.C.

Hooper, P. and C. Mann. (1989). "Exchange Rate Pass-Through in the 1980s: The Case of United States Imports of Manufactures."Brookings Papers on Economic Activity 1:297-337.

International Monetary Fund. International Financial Statistics, Various Years

Isard, P. (1977). "How Far Can We Push the Law of One Price?" American Economic Review 67:942-48.

Jabara, C. and N. Schwartz. (1987)."Flexible Exchange Rates and Commodity Price Changes: The Case of Japan." American Journal of Agricultural Economics 69:580-590.

Johnson, P. R., T. Grennes and M. Thursby. (1977). "Devaluation, Foreign Trade Controls, and Domestic Wheat Prices."American Journal of Agricultural Economics 59: 619-627.

Jordan, K. (1995). Market Structure and Government Policy Preferences: The United States Winter Market for Fresh Tomatoes. Ph.D. Dissertation. University of Florida, Gainesville.

Jordan, K. and J. VanSickle. (1995a). "Integration and Behavior in the United States Market for Fresh Tomatoes." Journal of Agriculture and Applied Economics 27:127-137.

Just, R. E. and Chern, W. S. (1980). "Tomatoes, Technology, and Oligopsony." Bell Journal of Economics 11:584-602.

Kalaitzandonakes, N. and T. Taylor. (1990). "Competitive Pressure and Productivity Growth: The Case of Florida Vegetable Industry." Southern Journal of Agricultural Economics 22:13-20.

Khosla, A. and J. Teranishi. (1989). "Exchange Rate Pass-Through in Export Prices: An International Comparison." Hitotsubsahi Journal of Economics 30:31-48.

Kim, Y. (1990). "Exchange Rates and Import Prices in the United States: A Varying Parameter Estimation of Exchange rate Pass-Through." Journal of Business and Economic Statistics 8:305-315.

Kmenta, J. (1986). Elements of Econometrics, Macmillan, New York.

Knetter, M. (1993). "International Comparisons of Pricing-to-Market Behavior." American Economic Review 83:473-486.

Knetter, M. (1989). "Price Discrimination by United States and German Exporters." American Economic Review 79:198-210.

Kolstad, C. and A. Burris. (1986). "Imperfectly Competitive Equilibria in International Commodity Markets." American Journal of Agricultural Economics 68:28-36.

Kreinin, M. E. (1977). "The Effects of Exchange Rate Changes on the Prices and Volumes of Foreign Trade." International Monetary Fund Staff Paper 24:297-329.

Krueger, A. O., M. Schiff and A. Valdes. (1988). “Agricultural Incentives in Developing Countries: Measuring the Effects of Sectoral and Economy-wide Policies.” World Bank Economic Review 2:255-272.

Krugman, P. (1987). Pricing To Market When Exchange Rate Changes. In S. Arndt and J.D. Richardson (eds). Real Financial Linkages Among Open Economies. The MIT Press, Cambridge.

Krugman, P. and R. Baldwin. (1987). "The Persistence of United States Trade Deficit." Brookings Papers on Economic Activity 1:1-43.

Lipsey, R. Z., L. Molineri and I. B. Kravis. (1991). “Measurement of Prices and Price Competitiveness in International Trade in Manufactured Goods.” In P. Hooper and J. D. Richardson (eds). Issues in Measurement and Empirical Research. University of Chicago Press.

Liu, P. C. (1993). "Purchasing Power Parity in Latin America: A Co-Integration Analysis." Weltwirtschaftliches Archiv 128:662-79.

Ljung, G. and G. Box. (1979). "On a Measure of Lack of Fit in Time Series Models." Biometrica 66:265-270.

Lopez, R. E. (1984). "Measuring Oligopoly Power and Production Responses of the Canadian Food Processing Industry." Journal of Agricultural Economics 35:219-230.

Love, J. and G. Lucier. (1996). Florida-Mexico Competition in the United States Market for Fresh Vegetables. Vegetables and Specialities Situation and Outlook Report. USDA, ERS, VGS-268.

Mann, C. (1986). "Prices, Profit Margins and Exchange Rates". Federal Reserve Bulletin 72 :366-379.

Mehra, Y. (1991). "An Error-Correction Model of U.S. M2 demand." Economic Review, Federal Reserve Bank of Richmond 77:3-12.

Melick, W. (1994). "Aggregate Exchange Rate Pass-Through: Instability and Inference." Journal of Economic Integration 9:427-443.

Melvin, M. (1992). International Money and Finance, Third Edition. Harper Collins Publishers, New York.

Menon, J. (1993a). "Exchange Rates and Prices of Australian Manufactured Exports." Weltwirtschaftliches Archiv 128:695-710.

Menon, J. (1993b). "Exchange Rate Pass-Through: Australian Imports of Motor Vehicles." International Economic Journal 7:93-109.

Menon, J. (1994). "The Theory of Exchange Rates and Traded Goods Prices in the Short-run." Economia Internatzionale 47:55-68.

Menon, J. (1995a). "Exchange Rate Pass-Through." Journal of Economic Surveys 9:197-231.

Menon, J. (1995b). "Price and Activity Effects in International Trade: Cointegration, Aggregation and Prices." Hitotsubashi Journal of Economics 36:47-60.

Mohamed, A. (1990). "The Impact of Domestic Market Structure on Exchange Rate Pass-Through." Federal Reserve Bank of Philadelphia Working Paper No. 90-25.

Moreno, R. (1989). "Exchange Rates and Trade Adjustment in Taiwan and Korea." Federal Reserve Bank of San Francisco Economic Review 2:30-48.

Morkre, M. (1993). "The Effects of Subsidized Imports on Domestic Industry: A Comparison of Market Structures." Journal of Policy Modeling 15:49-61.

Nelson, C. and Plosser, C. (1982). “Trends and Random Walks in Macroeconomic Time Series.” Journal of monetary Economics 10:139-162.

Officer, L. (1990). "The Law Of One Price: Two Levels of Aggregation." In T. Grennes. (ed) International Financial Markets and Agricultural Trade. Boulder CO: Westview Press.

Ohno, K. (1989). “Export Pricing Behavior of Manufacturing: A U.S.-Japan Comparison.” International Monetary Fund Staff Papers 36:550-579.

Organization for Economic Co-operation and Development. (1992). The Tomato Market in OECD Countries, OECD, Paris.

Paarlberg, P. L. and P. C. Abbott. (1986). “Oligopolistic Behavior by Public Agencies in International Trade: The World Wheat Market.” American Journal of Agricultural Economics 68:528-542.

Parsley, D. (1993). "Exchange Rate Pass-Through: Evidence from Aggregate Japanese Exports." Southern Economic Journal 60:454-462.

Phillips, R. W. (1988). The Pass-Through of Exchange Rate changes to Prices of Imported Manufactures. Australian National University, Canberra. Center for Economic Policy Research, Discussion Paper No. 197.

Pick, D. H. and T. A. Park. (1991). "The Competitive Structure of United States Agricultural Exports." American Journal of Agricultural Economics 73:133-41.

Plunkett, D. (1996). “Mexican Tomatoes: Fruits of New Technology.” Vegetables and Specialities Situation and Outlook Report. USDA, ERS, Washington, DC, VGS-268.

Pompelli, G. K. and D. H. Pick. (1990). "Pass-Through of Exchange Rates and Tariffs in Brazil-United States Tobacco Trade." American Journal of Agricultural Economics 72:677-81.

Ramos, T. (1996). NAFTA Trade and Economic Development Database (Computer File), ERS, USDA, Washington DC.

Richardson, J. D. (1978). "Some Empirical Evidence on Commodity Arbitrage and the Law of One Price," Journal of International Economics 8:341-351.

Rockerbie, D. W. (1992). "Exchange Rates, Pass-Through, and Canadian Export Competitiveness: An Analysis Using Vector Autoregressions." Applied Economics 24:627-34.

Schmitz, A., R. Firch and J. Hillman. (1981). "Export Dumping and Mexican Winter Vegetables." American Journal of Agricultural Economics 63:645-654.

Schuh, G. E. (1974). “The Exchange Rate and U.S. Agriculture.” American Journal of Agricultural Economics 56:1-13.

Segarra, E. (1992). “The Proposed United States-Mexico-Canada North American Free Trade Agreement: The Mexican Perspective.” Southern Journal of Agricultural Economics 24:45-54.

Shane, M. (1990). “Exchange Rates and U.S. Agricultural Trade.” Agricultural Information Bulletin No. 586. International Economics division, USDA, ERS, Washington, DC.

Smith, H. (1988). "United States Agricultural Export Competitiveness: Export Levels, Trade Shares and the Law of One Price." Federal Reserve Bank of Dallas Economic Review 14-25.

Taylor, T. and R. Kilmer. (1988). "An Analysis of Market Structure and Pricing in the Florida Celery Industry." Southern Journal of Agricultural Economics 20:35-43.

Tefertiller, K. and R. Ward. (1995). "Revealed Comparative Production Advantage: Implications for Competitiveness in Florida's Vegetable Industry." Agribusiness 11:105-115.

Thompson, G. D. and J. S. Hillman. (1989). "Agricultural Trade Between the United States and Mexico: The Impact of Mexico's Foreign Debt." American Journal of Agricultural Economics 71:1123-34.

Tyrell, T. and T. D. Mount. (1982). “A Nonlinear Expenditure System Using A Linear Logit Specification.” American Journal of Agricultural Economics 64:539-546.

United States Department of Agriculture. Marketing Mexico's Fruits and Vegetables. Washington, DC, 1978-1996.

United States Department of Agriculture. NAFTA Agricultural Fact Sheet: Fresh Tomatoes. Foreign Agricultural Service, January, 1997.

United States Department of Agriculture. Fresh Fruit and Vegetable Shipments: By Commodities, States and Months. Agricultural Marketing Service, Fruit and Vegetable Division, Washington, DC.

United States Department of Agriculture. Vegetable Series: U.S. Monthly and Season Average Grower Price, Various Annual Issues. National Agricultural Statistics Service, Washington, DC.

United States Department of Commerce. United States Import History by Commodity and Origin. Foreign Trade Division, Bureau of the Census, Washington, DC 20233.

United States International Trade Commission. (1995). Fresh Winter Tomatoes. Publication 2881, Washington, DC.

United States International Trade Commission. (1996). Fresh Tomatoes and Bell Peppers. Public Version of Pre-hearing Report to the Commission in Investigation No. TA-201-66. Washington, DC.

VanSickle, J. J. (1996). Florida Tomatoes in a Global market. Food and Resource Economics Department. University of Florida, Gainesville.

VanSickle, J. J., E. Belibasis, D. Cantliffe, G. Thompson and N. Oebker. (1994). Competition in the Winter Fresh Vegetable Industry. USDA. ERS, Washington, DC. Agricultural Economic Report No.691.

Venables, A. J. (1990). "Microeconomic Implications of Exchange Rate Variations." Oxford Review of Economic Policy 6:18-27.

Villa-Issa, M. R. (1990). "Performance of Mexican Agriculture: The Effects of Economic and Agricultural Polices." American Journal of Agricultural Economics 72:744-54.

Wilamoski, P. (1994). "Exchange Rate Pass-Through: Testing For Structural Change and its Causes." International Trade Journal 8:321-46.

Williams, G. W. and C. P. Rosson. (1992). "Agriculture and the North American Free Trade Agreement." Choices Fourth Quarter.

Yang, Y. and M. Hwang. (1994). "Price Behavior in Korean Manufacturing." Review of Economics and Statistics 76:461-470.

Yumkella, K., L. Unnevehr and P. Garcia. (1994). "Noncompetitive Pricing and Exchange Rate Pass-Through in Selected United States and Thai Rice Markets." Journal of Agriculture and Applied Economics 26:406-16.

Zepp. G. (1982). "The Peso devaluation and Florida-Mexico Competition in Winter Fresh Vegetables." Marketing Mexico's Fruits and Vegetables, USDA, Washington, DC. Annual Report 1981-82.

Zepp, G. and R. Simmons. (1979). Producing Fresh winter Vegetables in Florida and Mexico. USDA, Washington DC. Economics, Statistics and Cooperative Services, SCS-73.

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I certify that I have read this study and that in my opinion it conforms to acceptable standards of scholarly presentation and is fully adequate, in scope and quality, as a dissertation for the degree of Doctor of Philosophy.

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